THE INTELLECTUAL OBSERVER.

MAY, 1865.

DERVISHES AND HADJIS.

BY ARMINIUS VÁMBÉRY.

The Dervish is the veritable personification of Eastern life. Idleness, fanaticism, and slovenliness are the features which in him are regarded as virtues, and which everywhere are represented by him as such. Idleness is excused by allusion to human impotence, fanaticism explained as enthusiasm in religion, and slovenliness justified by the uselessness of poor mortals to struggle against fate. If the superiority of European civilization over that of the East was not so clearly established, I should almost be tempted to envy a dervish, who, clad in tatters and cowering in a corner of some ruined building, shows by the twinkle in his eye the happiness he enjoys. What a serenity is depicted in that face; what a placidity in all his actions; what a complete contrast there is between this picture and that presented by our European civilization! In my disguise as a dervish, it was chiefly this unnatural composure which made me nervous, and in the imitation of which I made of course the greatest mistakes. I shall never forget one day at Herat, when, after reflecting on the happiness of the early termination of the painful mask I had been wearing for so many months, I suddenly jumped up from my seat, and in a somewhat excited state began to pace up and down the old ruin which gave me shelter. A few minutes afterwards I perceived that a crowd of passers-by had collected at the door, and that I was the object of general astonishment. Seeing my mistake, I blushingly resumed my seat. Soon afterwards, several people came up to ask me what was the matter with me, whether I was well, etc. The good people thought I was deranged, for to oriental notions a man must be out of his senses if, without necessity or a special object in view, he suddenly leaves his seat to pace up and down a room.

As the dervish represents the general character, so he does

the different peoples of the East. It is true, Mahommedanism enforces the dogma, "All the true believers are brethren;" but the origin and home of the different sects are easily recognized. Bektashi, Mevlevi, and Rufai are principally natives of Turkey, because Bektash, the enthusiastic founder of the Janissaries, Molla Djelaleddin Rumi, the great poet of the Mesnevi, lived and are buried in Turkey; the Kadrie and Djelali are most frequently met with in Arabia, the Oveisi, and Nurbakhchi Nimetullahi in Persia, the Khilali and Zahibi in India, and the Nakishbendi and Sofi Islam* in Central Asia. The members of the different fraternities are bound together by very close ties; apprentices (Murid) and assistants (Khalfa) have to yield implicit obedience to the chief (Pir), who has an unlimited power over the life and property of his brethren. But these fraternities do not in the least trouble themselves about secret political or social objects, as is sometimes asserted in Europe by enthusiastic travellers, who have even discovered freemasons amongst the Bedouin tribes of the Great Desert. The dervishes are the monks of Islamism; and the spirit which created and sustains them is that of religious fanaticism, and they differ from each other only by the manner in which they demonstrate their enthusiasm. For instance, whilst one of these religious orders commands constant pilgrimages to the tombs of saints, the other lays down stringent rules for reflection on divine infinity and the insignificance of our existence. A third compels his votaries to occupy themselves day and night with repeating the name of God (Zikr), and hymns (Telkin); and it cannot surprise us to learn that the greater number of a company which has continually been calling out with all its might "Ja hu! Ja hakk! La illahi illahu!" are seized with *delirium tremens*. The orthodox call this condition Medjzub; *i. e.*, carried away by divine love, or to be in ecstasy. A person to whom such a fortunate event happens, for as such it is regarded, is envied by everybody; and as long as it lasts, the sick and the maimed and barren women try to get in his immediate presence, taking hold of his dress, as touching it is supposed to have healing power.

What the dervishes are able to do during the ecstasy caused by *Zikr*, I had once an opportunity of witnessing in Samarkand. In Dehbid, close to the tomb of the Makhdun Aazaram, one of these howling companies had grouped themselves around the Pir (chief) of that district. At first they contented them-

* Sofi Islam is a sect which originated about thirty years ago. Its founder, a Tadjik, from Belkh, was desirous of opposing the ever-increasing influence of the Nakishbendi. In this fraternity prevails the principle of communism and blood relationship. The Sofi Islamites wear a cap trimmed with fur, and are most frequently met with this side of the Oxus, as far as Herat, and also amongst the Turkomans.

selves with repeating the formula in a natural tone of voice, and almost in measured time. The chief was lost in the deepest thought, all eyes and ears were fixed upon him, and every motion of his hand and every breath he drew was audible, and encouraged his followers to utter wilder and louder ejaculations. At last he seemed to awake from his sleep-like reflections, and as soon as he raised his head all the dervishes jumped up from their seats like possessed beings. The circle was broken, and the different members began to dance in undulating motions; but hardly did the chief stand upon his feet than the enthusiastic dancers became so terribly excited that I, who had to imitate all their wild antics, became almost frightened. They were flying about, constantly dancing, right and left, hither and thither, some leaving the soft meadow and getting upon the rough stones, constantly dancing, till the blood began to run freely from their feet, still they kept on their mad excitement, till most of them fell fainting to the ground.

It is the same with dervishism as with all the other oriental institutions, customs, and manners; the more we penetrate towards the East, the greater is the purity with which they have been preserved. In Persia the dervishes play a much more important part than in Turkey; and in Central Asia, isolated as it has been from the rest of the world for centuries, this fraternity is still in full vigour, and exercises a great influence upon society. In my *Travels* I have frequently alluded to the position occupied by the *Ischan*, or secular priests, in Central Asia. Their influence may be called a fortunate one contrasted with the fearful tyranny existing in those countries. This is the reason why every one occupies himself with religion; every one tries to pass himself off as a worker of miracles (Ehli Keramet), or if he fails in that, he endeavours to be recognized as a saint (Veli Ullah). Those who make the interpretation of the sacred writings their business, are great rivals of the *Ischans*, who by the mysticism by which they surround themselves, enjoy a large share of popular esteem. The native of Central Asia, like the wildest child of Arabia, is more easily imposed upon by magic formulas and similar hocus-pocus than by books. He may dispense with the services of a Mollah, but he cannot do without a Ischan, whose blessing (*fatika*) or breath (*hafesi*) is required when he sets out on one of his predatory expeditions, and upon which he looks as a talismanic power, when moving about his herds, his tent, or the wilds of the desert.

After the Ischanes, the most interesting class are the mendicant dervishes (Kalenter*), which the Kirguese and Turko-

* Kalentor is a corruption of the old Persian Kelantor, *i. e.*, the more powerful. In Eastern Persia the title is still given to the judges of villages.

mans call Kudush* or Divane (insane). In the whole of the great deserts which stretch from the eastern boundaries of China to the Caspian Sea, it is only these people, in their ragged dress, who are able to move unmolested. They do not take any notice of the differences of tribe or family, and the mighty words *Jaghi* or *Il* (friend or enemy) have to them no meaning. In travelling along they join whomsoever they meet, be it a peaceful caravan or band of *robbers*. The dervishes who travel through Kirguese or Turkoman steppes are generally this class of people, who from a strong inclination to do nothing, follow a trade which, throughout the East, is considered respectable, viz., that of a mendicant. All they have to acquire is a few prayers and a certain power of mimicry, with which the chiromantic feats are performed, and I have never seen a nomad who has not been moved when he found himself in the close presence of one of those long-haired, bare-headed, and bare-footed dervishes, who with his fiery eyes, stared hard at the son of the desert, and whilst shaking his Keshkul† howled a wild "*Ja hu!*"

The arrival of one of these fakirs in a lonely group of tents is regarded as a joyful event, or almost a festival; it is of especial importance in the eyes of the women; and the time of his arrival is differently interpreted. Early in the morning signifies the happy birth of a camel, or a horse; at noon a quarrel between husband and wife; and in the evening a good prospect of marriage to the marriageable daughters. The dervish is generally taken in hand by the women, and is well supplied with the best things the tent contains, in hopes that he may be tempted to produce from beneath his battered dress some glass beads, or other talisman. Alms, which amongst the nomads seldom consist of money, are rarely denied him; and he often receives an old carpet, a few handfuls of camel hair or wool, or an old garment. He may also stop with the family for days, and move about with it without his presence becoming a burden. If the dervish possesses musical talent, *i. e.*, able to sing a few songs and accompany himself on the two-stringed instrument called Dutara, he is made much of, and has the greatest difficulty in getting away from the hospitable host.

It is very seldom that dervishes are insulted or ill-treated; this, however, is said to be the case amongst the Turkoman, whose rapacity knows no bounds, and prompts them to commit incredible acts of cruelty. A dervish, from Bokhara, of

* Kuddus (Hungarian: Kódus, *i. e.*, beggar), is derived from Kudurmak, to become mad; thus the Arabs call the dervishes "Medjnun," *i. e.*, insane.

† Keshkul is a vessel formed of half a cocoa-nut, the *vade mecum* of the dervishes, in which he plunges all the food he has collected by begging, whether dry or fluid, sweet or sour. Such a dish of *tutti frutti* would but ill suit our gastronomers, and yet how delicious it tasted to me after a long day's march.

robust figure and dark curly hair, whom I met at Maymene, told me that a Tekke Turkoman, prompted by the thirty ducats which his athletic figure promised to fetch in the slave market, made him a prisoner, to sell him a few days afterwards. "I pretended," my colleague continued, "to be quite unconcerned, and repeated the *Zikr* and *Tesbih*, whilst shaking my iron chains. The time was fast approaching when I was to be taken to the market, when suddenly the wife of the robber of my liberty and person was taken ill, and prevented him from starting. He seemed to see in this the finger of God, and began to be pensive, when his favourite horse, refusing to eat his food, showed signs of illness." This was enough. The robber was so frightened that he removed the chains of his prisoner, and returned to him the things he had robbed him of, begging him to leave his tent as soon as possible. Whilst the Turkoman impatiently awaited the departure of the ominous beggar, the latter fumbled about his dress, and pretended that he had lost a comb, which his chief had given him as a talisman on the road, and without which he could not go a single step. The nomad returned in great haste to the place where the plunder had been kept, and as the comb did not turn up he became still more frightened, and promised the dervish the price of twenty combs if he would only take a single step beyond the boundary of his tent. The cunning Bokhariat saw he was master of the situation; he pretended to be inconsolable about the lost property, which he kept in his pocket, and did not lose at all, and declared that he now would have to remain for years in the tent. Imagine the confusion of the deceived and superstitious robber! Like a madman, he ran about asking his neighbour for advice. Formal negotiations were now commenced with the dervish, to whom, finally, a horse, a dress, and ten ducats were presented, to make up for the loss of the comb, and on condition that he should leave a tent, whose proprietor will probably think twice before he ventures again upon molesting a travelling dervish.

Besides the dervishes, who, as physicians, miracle-working saints, or aimless vagabonds, are wandering about in Central Asia, there is a class called *Khanka neshin*, or convent dwellers, who always wish to appear as the poorest, and are, without doubt, the most contemptible fellows in the world. Generally speaking, they are opium eaters, who by their excessive filth, skeleton-like body, and frightfully distorted features, present a most repulsive appearance. The worst is that they do not confine themselves to practising this fearful vice themselves, but, with a singular persistency, endeavour to make converts amongst all classes, and, supported by the want of

spirituous drinks, they succeed but too frequently in their wicked attempts. What surprised me most was that these wretched people were regarded as eminently religious, of whom it was thought that, from their love to God and the Prophet, they had become mad, and stupefied themselves in order that in their excited state they might be nearer the beings whom they loved so well.

Speaking of dervishes, we may mention a class of hypocrites, who, under the pretence of carrying out sacred vows, indulge in their desire to travel, and after their return assume, under the title of Hadji Pilgrims, authority and a good social position. The Koran says: "*Hidju ala beïti min isti-taatun Sebila*"—"Wander to my house (*Kaaba*) if circumstances permit." These "circumstances" are reduced to the following seven conditions by the commentators:—The pilgrimage must be undertaken with, 1st, sufficient money for travelling expenses; 2nd, bodily health; 3rd, in an unmarried state; 4th, without leaving debts behind; 5th, in times of peace; 6th, overland and without danger; and, 7th, and by persons who have reached the age of puberty. That our good Tartars ill observe these conditions will be evident to all who have some idea about the countries situated between Oxus and Taxartus. In Persia people go to Kerbela, Meshed, or Mekka, only when sufficient funds enable them to do it comfortably. In Central Asia, on the contrary, it is always the poorest class who undertake pilgrimages. A certain taste for adventure, coupled with religious enthusiasm, are the two motives which prompt the inhabitants of Central Asia to start from the remote East for the tomb of their Prophet. True, they do not suffer any material losses, for a beggar's bag is a money-bag; but they frequently lose what is most precious to them—their life—as every year at least one-third of the pilgrims from Turkistan die from exposure to the climate.

This sacred, or profane, desire to travel, braves all danger; this vague thought of tearing himself away from his family, and friends, and countrymen, to see the wide world, surrounds the hadjis with a certain poetry. I have lived weeks with my companions, and yet it always interested me to behold them, palm-staff in hand, as a sacred memento of Arabia, vigorously making their way over the deep sand or mud. They were returning happily to their homes; but how many did I meet who had only commenced their long and tedious journey, and yet they were equally happy. On my road from Samarkand to Teheran I had as a companion a native of Chinese Tartary, who, in total ignorance of the route he had to take, asked me every evening, even when we were yet at Meshed, whether we should see to-morrow, or at the farthest after to-morrow,

the minarets of Mekka? The poor fellow had no idea how much he would have to endure before he reached his destination. However, this should not surprise us, when we remember that during the time of the Crusades so many honest Teutons undertook a pilgrimage to the Holy Land, and after two or three days' journey hoped to behold the walls of Jerusalem.*

The routes to Arabia adopted by the pious Tartars are the following, viz., 1, Yarkend, Kilian, Tibet, Kashmir;† 2, through Southern Siberia, Karyan, and Constantinople; 3, through Afghanistan and India to Djedda; 1, through Persia, Bagdad, and Damascus. None of these routes is a comfortable one, and the amount of danger to be incurred is very much dependant upon the season of the year and the political state of the countries through which they pass. The travellers form themselves in larger or smaller companies, and elect a chief (*Chaush*) from amongst themselves, who also fills amongst them the office of *Imam* (the person who first says the prayers to be repeated by the rest), and who enjoys a considerable superiority over his companions. A visit to the Kaaba and the tomb of the Prophet (which may be paid at any season) is not so much the culminating point of the whole pilgrimage as the ascent of Mount Arafat. This can be made only once a year, viz., on the Kurban festival (10th Zil, Hidji), which is nothing more or less than the sacrifice of Abraham and Isaac dramatised. All those who have taken part in this festival, and have joined in the cry, "Lebeik, Allah!" (Command, oh God)—in allusion to Abraham's implicit obedience—are regarded as genuine hadjis. This cry of "Lebeik! lebeik!" uttered at the most solemn moment of the whole pilgrimage, seems also to have the deepest impression upon the pilgrim himself. My travelling companions, whenever they became excited, or were in a happy mood of mind, always alluded to it; and the stillness of the Tartaric deserts was often broken by this memento of the stony districts of Arabia.

However painful and heartrending separation from home may be when so long and dangerous a journey has to be undertaken, the joy which the hadjis experienced on their return fully counterbalances it. Friends and relations, informed of their near arrival, go out to meet them several days in advance. Hymns are sung, and tears of joy are shed when the hadji makes his entry into his native place. Every one wants to embrace him, to touch him, for the atmosphere of

* See Nösselt's Geschichte für Töchter schulen I., who also states that many pilgrims, ignorant of the road, allowed themselves to be led by a frightened goose which ran before them.

† From Yarkend (Jarkend) to Kilian, on the boundary line, are three days' journey; from there by way of Tagarma and Kadun to Thibet, twenty days; and thence to Kashmir, fifteen days.

holy places still surrounds him, the dust of Mekka and Medina still covers his garments. In Central Asia the hadji is held in much greater esteem than in any other Mohammedan country. It has cost him much to obtain his dignity, but he is amply repaid. Respected and supported by his fellow-citizens, he is better protected against the tyranny of the government than any other citizen. The title of a "*hadji*" is a patent of nobility, which during his lifetime he parades on his seal, after death on his tombstone.

The hadjis—of course such as are not mere beggars—often transact, during their pious pilgrimage, a little commercial business. "*Hem tidjaret hen ziaret*," "commerce and pilgrimage together," are not allowed by their religion; but nobody seems to suffer any pricks of conscience in taking to his co-religionist in Arabia a few articles from distant Turkomania. The products of Bokhara, and other holy places of Central Asia, are in high esteem amongst the people of Arabia; besides, every one wishes to show a hadji some favour, and is easily induced to pay double the value for any article offered. This small trade is carried on between the easternmost point of Islamitic Asia to the Galata bridge of Constantinople. Amongst the crowd of that famous capital one often sees a Tartar whose features contrast as strangely with the rest of the population as the colours of the thin silk kerchief differ from those of an European manufacture. Fine ladies seldom become purchasers of such articles, but old matrons are frequently seen, inspired by feelings of piety, paying a good price for them, pressing them repeatedly to their face and forehead while repeating a loud "*Allahumu Sella*," and continuing their walk.

That the successful sale of the exported articles leads to the importation of similar merchandise, needs no confirmation. No hadji leaves the holy places without making some purchases. At Mekka he lays in a stock of scents, dates, rosaries, and combs, but especially water from the sacred well, called Zem Zem.* In Yambu and Djidda are bought European goods; these go by the name of Mali Istambul, *i. e.*, Stamboul goods, as the unbelieving Franks must not obtain credit for anything, and they consist of penknives, scissors, needles, thimbles, etc. Aleppo and Damascus enjoy the reputation of supplying the best Misvak, a fibrous root, used as tooth-brushes by all pious Moslems. In Bagdad are bought a Hirkia, made of camel's hair, and of superior quality at this

* Zem zem is the name of a famous well on the road, of miraculous power, the water of which is exported in small vessels to all Islamite countries, as a single drop of it, taken just at the moment of death, frees from five hundred years of purgatory. The origin of the well is ascribed to Ismail, who, after being left behind by Hagar, stamped his little foot, and made the well spring up.

place, as it is this kind of garment which the Prophet is said to have worn next his skin. Finally, in Persia, ink powder, and pens, made of canes, are purchased. In Central Asia all these articles are great curiosities, and they are paid for handsomely, partly from necessity, partly from religious motives.

Generally speaking, a caravan of hadjis, I mean one whose character has been well inquired into, are the best travelling companions one can have in Central Asia, or rather in the whole of the East, provided one can manage to agree with them. With regard to the travelling necessaries, the hadji is well supplied, and it was always surprising to me to see how a man, who had only one poor donkey he could call his own, could make a display of a separate tea-service* (*à la Tartar*), pilou apparatus, and carpet, when arrived at the station at which we halted. Nobody is more clever than a hadji in negotiating, be the people he has to deal with believers or unbelievers, nomades or agricultural tribes. A hadji may be converted into anything, he being thoroughly penetrated by the principle, "*Si fueris Romæ.*" Instead of being cast down and gloomy, as his ragged exterior would lead us to suppose, he is of a merry disposition, and, during the long marches, the greatest saint and miracle-maker occasionally indulges in a profane joke. The comicality of these generally serious faces has often made me forget the privations which I was myself undergoing.

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GOLD CURRENCY IN INDIA.

BY JOSEPH NEWTON.

THE recent introduction, under warrant of Government, of a gold currency throughout the three Presidencies of British India, is an event of sufficient importance to justify some remark. The innovation is one which must create considerable excitement among the native inhabitants, who have always entertained a very strong prejudice in favour of silver money. That that excitement will be of short duration, and that the prejudice will soon die a natural death, may be foretold without much prescience, and without a shadow of a chance of the non-fulfilment of the prophecy.

The advantages likely to arise from the existence of a gold coinage in India had indeed forced themselves upon the attention of such of the wealthy and more intelligent natives as were engaged in the transactions of commerce, long before the order in council legalized its use in our Indian possessions. The Government, therefore, in admitting gold coins to a legal position, have only recognized actual facts, and inaugurated a financial reformation which growing commerce and enlarged experience had proved to be not only expedient but absolutely necessary. It is not a theoretical crotchet, but the enlightened recognition of a want and the application of a means of supplying it. The change would probably have been effected at an earlier date, but for the circumstance that the coined sovereign and half-sovereign do not exactly tally with any combination of silver coins circulating in India. The alternatives presented for overcoming this inconvenience were to disregard the relative difference of value between the rupee and the sovereign, or else to remodel the silver coinage of that country, and make it harmonize in its divisions with our own gold currency. In the latter case the serious evil would have had to be encountered of inciting much popular discontent, if not of something worse, and therefore the idea was necessarily abandoned. It remained to adopt the former, or to leave things as they were. Thanks principally to Sir Charles Trevelyan, the late financial secretary to the Government of Bengal, the determination was arrived at to make the sovereign and the half-sovereign current at the value of ten and five rupees respectively, and thus to confer, apparently, a favour upon the present holders of silver money.

The legalization of a gold currency throughout the Presidencies cannot be construed, by any perversity of reasoning or ingenuity of argument, into an arbitrary interference with the

native coin, so to speak, but must be regarded as a superaddition to it, rendered imperative by the extension of trade and traffic, and one which will facilitate largely the prosecution of both. It is not impossible that in the fulness of time, when the native population shall have become familiar with the gold coins of Great Britain, and can appreciate their portability, the sovereign may become the unit of commercial calculation in India as it is at home. Thus the way would be paved for the introduction of English silver coins as well. Such a consummation, however, if it be attained at all, must be arrived at by natural, and not artificial means, and cannot be forced.

A perfect assimilation and uniformity of the coinages of British India, Australia, and the mother country, would, no doubt, be of immense advantage to all; but, like other reformations where nationalities, prejudices, and peculiarities of habit consequent upon them, have to be combated, the change will be the work, not of a day, but of a generation at least. Perhaps the Decimal System may eventually prove to be the lever by means of which the improvement is to be effected. It is exceedingly probable that the general circulation of a gold currency in India may lead to a similar result in China. There is a great interchange of bullion and specie constantly going on between the two countries, and a common and well understood coinage of gold would, undoubtedly, be found conducive to a facility of remittance and disbursement. The Chinese authorities, of course, exercise exclusive control over the currency of China, but English coins, from their known value and unvarying degree of purity, pass current, or at a very slight depreciation, at present, and it is pretty certain that Chinese merchants will accept the same coin when they know that it is already a legal tender in India, with which place they have close and facile communication.

In this way then it is, to say the least of it, not unlikely that our own gold coinage will find its way not only to Chinese seaports, but up the great Chinese rivers to the inland seats of trade of that vast, populous, and mysterious country. Thus may be foreseen the opening up of a great future for the gold coinage of England, and a gradual lapsing of the dollar, rupee, and general silver currencies of China and India into the subsidiary positions which silver coins occupy in almost all other states of the globe. Whether the relative values of the two precious metals will be affected by this social change, is a question which as yet can only be suggested. It is positive, nevertheless, that the legalization of gold, as a medium of circulation in our Indian territories, will speedily liberate enormous quantities of the inferior material, and that this latter will flow over a much wider area than it could while it remained

an exclusive standard. Without entering into a discussion of the ulterior consequences of the extensive gold discoveries of the last twelve years, and the future price of that metal—which form important and interesting subjects of debate in themselves—it may be remarked that a no less eminent authority than M. Chevalier contends that the extensive employment of a gold coinage in France has retarded a fall in the value of gold. How likely, then, that the circulation of gold coins among the millions of inhabitants of India will retard it still further?

During the reign of Napoleon III. gold coins have indeed almost displaced those of silver, except as to the smallest denominations of them, and thus the order of things, as compared with the reign of his uncle, has been reversed. An extraordinary exportation of silver to the East, where it has been hitherto in great request, has resulted from the alteration. For example, the export of silver from France in the year 1853 was valued at nine millions sterling; in 1854, it was more than ten millions and a half; in 1855, it amounted to twelve millions and three-quarters; while in 1857 it had reached eighteen millions and a-half. Since that period the exports have lessened in value, because the fountains whence they were drawn had become comparatively dry. The adoption of a gold currency in India will check this draining of silver from Europe yet more effectually, and the East will naturally absorb gold from Australia to supply the place of the subsidiary metal, for which it previously yearned. Perhaps, indeed, the masses of silver, borrowed as it were from France and, in a lesser degree, from England, may flow back again, by the action of the self-same law which drifted them away! The tendency of the new arrangement will inevitably be towards such a restitution.

One other reform it would be well for the Government to consider, in connection with the gold currency of India, and it refers to the Australian sovereign and half-sovereign. Those coins will find their way to India, as a consequence of the recent enactment, and they should be at once, therefore, imperialized. Their distinctive and comparatively inelegant impressions render them in every way a nuisance, when intermixed with our own gold money, and that inconvenience will be found intolerable among Her Majesty's lieges in India. It is not enough to make the Sydney coins simply a legal tender. They should forthwith be assimilated in appearance, as they are in weight, fineness, and intrinsic value, to those issued from the British Mint.

This is an essential addendum to the wise measure of reform to which we have adverted, and without which that

reform will be shorn of much of its usefulness. The demand for gold coins, both from England and Australia, will be for several years to come very great, and it is desirable that there should be no incongruity in the emanations from the stamping presses of the Royal establishment in London and its branch at the Antipodes.

THE LUNAR TAURUS (S.) AND ARGÆUS.—OCCULTATIONS.

BY THE REV. T. W. WEBB, A.M., F.R.A.S.

We recently described the northern division of the lunar range denominated *Taurus*, and have now to proceed to its southern region, which lies between the S.W. angle of the *Mare Serenitatis* (E) and the N.W. of the *M. Tranquillitatis* (D). The direction of the ridges which compose it is so exclusively S.S.W., that it even flattens two sides of the considerable craters *Littrow* (a double formation, next on the S. to *Lemonnier*, the bay described in our last paper), and *Maraldi* (a little further S.W.). S. of *Littrow* and S.E. of *Maraldi* lies a more conspicuous crater, *Vitruvius*, nineteen miles across, remarkable for its contrast of reflective power, the interior having only 2°, the ring 7° to 8° of brightness. Its E. side is 4500 feet above the bottom. Lohrmann remarks that it has a beautiful central hill. "The neighbourhood of *Vitruvius*," say B. and M., "is, in respect of colouring and luminosity, one of the most remarkable in the lunar surface, and its aspect alone quite sufficient to set aside the idea that the moon is nothing but a wide field of ice and snow, or, generally speaking, thoroughly homogeneous in its component parts. . . . The sea is here considerably dark, and this dark colouring extends itself in one of the narrow bays as far as the N. edge of *Vitruvius*. Other portions, on the contrary, show a mixture of brighter and darker points, compared with which the rest possesses an almost bluish aspect." Among the many island-like hills, which reach out from *Vitruvius* into the sea, B. and M. observe that a high mountain, rising furthest to the east, "elevates itself 8384 feet above the E. surface, and 5850 feet above the bay to the W. At its broad southern foot stand two craters—one large but barely perceptible, and another small, very distinct, 6° bright in full moon." Lohrmann considers this ridge, with some curious hills and valleys on its

N.W. side, the most remarkable region in the whole of his Section III., which forms a square of about twenty-five lunar degrees. Attention had been previously drawn to it, however, by Schröter. In his first observation, 1788, November 4, he describes it as a straight chain of five summits, divided by parallel ravines, about thirty-seven miles long, and of a greyish colour. This, contrary to the usual rule, he found brighter when nearer the terminator, 1791, December 30, at which time he ascertained the heights of each of the summits: that furthest to the S.W. cast no measurable shadow; the others ascended gradually through successive heights of 1980, 3170, and 6570, to 10,190 feet at the opposite extremity of the range, where it drops at once in a vast and awful precipice to the plain beneath it, as is shown by the extraordinary straightness of the N. side of its spire of shade, and the perpendicularity of its direction towards the terminator. Hence Schröter justly remarks that the materials of the moon must be, at least in part, as coherent as those of our globe; and adds: "Cliffs, in our terrestrial mountains, of even 200 to 300 feet and upwards, from which we look down into the valleys lying beneath them, make a powerful impression upon the susceptible observer of the works of God. What a vast nature-scene now would not open itself fully to mortal eye? And how great, beyond all imagination great, would not the impression be, if it could gaze away from the steeply set-off peak upon the soft lunar plains of the *M. Serenitatis* and *M. Tranquillitatis?*" Another measure, 1796, August 9, under less favourable circumstances, gave him 11,490 feet, the shadow being then very differently shaped and directed—a variation which he was disposed to ascribe to atmospheric obscuration, but which might more naturally be referred to irregularities in the surface of the plain below. In two other observations he again saw it straight-edged, but shorter, and cut off square at the end.

On two occasions only have I any record of having observed this magnificent precipice; the former, 1855, November, 14 d. 6 h., the moon being 5 d. old, and 3 d. 14 h. past the greatest S.E. libration, when, notwithstanding a very low position and dim and agitated image, I could perceive a grand pointed mass of shadow; the latter, 1858, February, 18 d. 7 h. 45 m.—4 d. 21½ h. after new, 4 d. 4 h. after greatest N.E. libration. The distance of the terminator at this time from the N.E. end of the range was about equal to its length; and the great steepness of the enormous cliff was finely shewn by the very straight edge of its shadow, cast across the plain to the terminator, by which, though already narrowing in rapidly, it seemed to be truncated; only 1 h. 15 m. later, the spire of shade

extended not more than ⅓ths of the distance to the terminator. I have entered into these minute particulars because the phenomenon seems to be of very transient character, and requires watching in order to catch its most striking aspect. In the first observation, part of the ring of the neighbouring crater, *Plinius* (No. 13), was just visible beyond the terminator in faint light; in the second, I have noted that the foot of the ring of the same cavity touched the terminator when the shadow was shortening. In either case *Theophilus* (85) was on the terminator, and the entrance of that grand crater into sunshine will serve as a convenient signal for the observer who wishes to secure a view of this remarkable shadow. I have once seen the mountain under the opposite illumination in the wane, but the effect was not at all striking; it was, however, too far in sunshine.

The representation of this chain by Lohrmann differs somewhat from the figures of Schr. and B. and M., but those best acquainted with the lunar surface and its delineation will not be the most perplexed by such deviations. It does not appear why B. and M. have not affixed to its apex one of those letters of reference which they have, in many instances, so liberally bestowed on objects of much less magnitude and interest; but as it is without any designation in their map I have begged permission to distinguish it by the name of *Mount Argæus*,* from some kind of analogy which may be traced between its position as an outlier of the lunar *Taurus*, with that of the Cappadocian summit bearing that name, which is somewhat similarly related to the *Taurus* range in Asia Minor.†

On the W. side of *Vitruvius*, or S.E. of *Maraldi*, lie two smaller craters side by side, the one (*Vitruvius* A.) as remarkable for its steepness as its neighbour, which is not quite so large, is for its soft contour. B. and M. observe that one would be tempted by their aspect to consider the latter as a sketch, the former a finished production.

To complete our survey of *Mt. Taurus*, we have yet to examine the S.W. plateau, containing the two large craters, *Macrobius* (11) and *Proclus* (12). The former is 42 miles in diameter, and at least 12,800 feet deep; less, however, on the

* *Celestial Objects for Common Telescopes*, p. 72.

† This grand summit, the culminating point of the ridge of Antitaurus which divides Cappadocia into two parts, is now called *Ardjish* or *Erjish Dagh*. It is an extinct volcano of very noble form, rising about 13,000 feet above the sea, and capped with perpetual snow. The western and loftier of its two conical peaks is described as "bristling with needles and furrowed with cavities;" at its foot lies an immense crater of vast depth. Many years ago an unfortunate American traveller was said to have lost his life from attempting a short cut in its descent. The ancient geographer Strabo relates that both the Mediterranean and Euxine seas were visible from its summit, but this seems highly improbable.

E. side, where there is a small crater of 6½°. *Proclus*, more than 18 miles across, is of difficult measurement in depth from its position. Schröter, from a rough attempt, considered it about 11,000 feet; B. and M. thought it exceeded 8300 feet on the W., which is the deeper side. The ring (using that expression in its stricter sense) is, after *Aristarchus*, the most luminous in the moon, having 8° of light in its S., and 9° in its N. portion; the interior has only 4°. It is a remarkable fact that, with so much brilliancy, it is barely to be distinguished on the night-side. From its position Schröter inferred that it ought to be nearly as conspicuous after the full as *Aristarchus* before it—he found its site, however, either quite dark or very feebly illuminated; and much less conspicuous than the less brilliant and worse situated *Manilius* and *Menelaus;* in total eclipse, too, it disappeared while other spots retained their visibility. B. and M., who agree with him as to the fact, explain it from the narrowness of the ring, which renders it imperceptible with such low powers as are alone suitable for examining the details of the dark hemisphere.

The restricted breadth in this instance of the highly reflective portion is a curious and suggestive fact, though it is difficult to assign any probable explanation of it. If the uppermost ridge of the wall were of especial elevation, and exhibited a graduated brilliancy, we might be led to the idea of a subsequent "weathering" from the action of a low-lying atmospheric stratum. But such is not the case, and the inference would be totally at variance with appearances elsewhere. Nor is it easy to see, in the face of many adverse instances, how that particular part would be liable to a bleaching process from more rapid cooling, or from the escape of vapour. If, on the contrary, we should incline to the supposition of an original difference in material, it is difficult to conceive how, amid the violent disturbance of an eruption on so extended a scale, any separate layer of matter could be so regularly deposited, and on so limited a space. The last discharge, possibly of ashes, might have a very distinct character, but would hardly exhibit itself merely as the summit of a lofty ring. We may, perhaps, collect that if we see its pristine condition, it never could have been one of great fluidity. But it must be admitted that the subject of lunar eruption is at present enveloped in much obscurity.

OCCULTATIONS.

May 2nd, κ Cancri, 5 mag., 7h. 53m. to 8h. 37m.—4th, 36 Sextantis, 11h. 1m. to 11h. 52m.

STICKLEBACKS AND OTHER NEST-MAKING FISH.

BY THE REV. W. HOUGHTON, M.A., F.L.S.

So much has of late years been written on the subject of Sticklebacks' nests, that few people, who take any interest in Natural History pursuits, can be ignorant of this extremely interesting fact; but, though the *fact* itself may be well known, I will venture to say that very few naturalists, comparatively speaking, can say they have ever *found* a fish's nest, and many would experience at first some little difficulty in discovering one. With a view, therefore, of facilitating the discovery of sticklebacks' nests this season, let me ask the reader to accompany me, in thought, any day in the months of May and June, to a pond or shallow stream. We will take with us a hand-net, and a tin or zinc can, for the capture of specimens, and a separate vessel for the nests and eggs. Let us suppose that we are on the bank of a clear pond; now for a stickleback's nest. I lie flat down upon the grass, and gently move away with my hand the floating leaves of the pond-weed (*Potamogeton natans*) and the green conferva, and look about me. Ah! do you see that little fish with crimson breast, and eyes like emeralds sparkling; see how wide awake he looks; depend upon it he has a nest not far away. And here it is, very plainly to be seen, partly covered with the sand and mud at the bottom of the water. Do you notice those roundish holes in the nest? Just touch it with the end of your walking-stick. Bravo, little stickles! he is at you like a bull-dog. How angry he is; if his power were equal to his will, he would swallow us all up. Now we can easily catch him. So I put my net near his nest, and over the net he swims, and out of the water he comes, and I put him in my collecting tin. Now, let us watch the nest, and see what will happen. Here they come, a hungry group of sticklebacks of all ages, and, alas! for the depravity of piscine nature, they are attacking the nest, and devouring the precious morsels inside. Let us restore the father fish to his native element and his familiar haunts. Quick, or the work of destruction will be complete. In he goes, and for a moment seems to have lost all recollection of past events. But no! he is "coming to himself," and witnesses that marauding crowd, and now he rushes boldly to the rescue of his house and family, first tilting at one and then at another of the enemy, until, *mirabile dictu*, he has driven every vanquished foe far from the scene of carnage, a very Diomede in the fray—

> "So raged Tydides, boundless in his ire,
> Drove armies back, and made all Troy retire."

But he has other work to do, he must repair the home of his young family so ruthlessly attacked; and now he hastens hither and thither, carrying in his mouth little bits of weed and stick, and dubs them into his nest, till the work of repair is completed. But we will try to find another nest, in order to examine it somewhat minutely. Now that the eye is familiar with the appearance of a nest, there will be no difficulty in discovering many more. There, you may count no less than four within a radius of a couple of yards! Let us take this one for examination. Bah! it has collapsed and lost its form now that it is out of the water; but see, embedded in the tangled mats of grass rootlets and decayed conferva filaments, lies a cluster of eggs. Look closely at it. What are those little black specs? Why, the eyes of the young ones to be sure; and see how the embryos jerk themselves about within the egg shell. We will catch the father fish if possible, and take the nest and eggs home to watch the development in a basin of water. Poor fellow! he evidently has a father's heart, and misses his loss. He will, however, soon make himself at home in the aquarium, and you will have the opportunity of witnessing further instances of parental affection in a small fish. You will see him frequently poised over the nest and agitating the water briskly with his fins. This he does in order to bring fresh currents to the eggs. In a few days, perhaps, the young ones will begin to appear—strange looking creatures to be sure, each with an undeveloped mouth, and an attached yolk sac, the contents of which become gradually absorbed by the body of the fish, and which are its sole nutriment in the early stages of its existence. If you move away a little fellow from the nest by means of a camel's-hair pencil, you will see the father fish start off in pursuit of the wanderer, seize him in his mouth, and shoot him out into the nest. Having "no ticket of leave," he is not allowed to stir above an inch or two from the precincts of the house.* Woe betide any other fish or small animal that dares approach the home of the little family. Quick as thought Paterfamilias rushes at him with dorsal and pectoral spines bristling horribly, and pursues him "tooth and nail" with relentless fury. If you come to this same pond in about three weeks' time, you may see many little groups of small fry disporting themselves close to the nest, into which they immediately pop should an enemy make an assault at an unguarded moment.

Well, all this is extremely interesting, and you ask

* Mr. J. H. Horsfall has observed that the male fish, on some occasions, devours his own infants. See INTELLECTUAL OBSERVER, No. XXV., Feb. 1864, p. 5.

whether this nest-making peculiarity is shared by any other fish besides sticklebacks.

Yes it is, and the fact was observed by Aristotle three hundred years before the Christian era. Not that the father of natural history, it is probable, had ever seen it himself. He simply gives the story as it had been related to him. Aristotle speaks of two kinds of fish which protect their eggs, one the Glanis, of which he writes:—"Of river fish the male Glanis manifests great care for its young; but the female, after having deposited her eggs goes away, but the male continues to guard them, paying only so much of attention to them as to drive away other fish, lest they should carry the eggs away. He does this for the space of forty or fifty days, till the fry have grown strong enough to escape being devoured by other fish. The fishermen know when it is guarding its eggs, for it drives off other fish, and utters a murmur as it rushes at them. So affectionately does it watch its eggs, that when the fishermen attempt to bring them out of deep into shallow water, the fish will not leave them." Aristotle also speaks of a fish called the Phycis, as being the only marine species which manifests the same anxious care for its brood. The *glanis* of the Ancient, and *glanidi* of the Modern Greeks, is found in the Achelous in Acarnania, and is a not very distant relative of the Sheat fish, or *Silurus glanis*, of which we have recently heard so much. The Phycis is probably a species of Goby, which Cuvier thought to be identical with the *go* of the Venetians. This fish is found in the Adriatic, and the male makes a nest of the roots of the grass-wrack (*Zostera marina*), that long, ribbon-shaped weed, with its beautiful leaves of grass green, common on our own shores. I suspect that this is the fish of which Ovid has sung in his Halieuticon* as the fish "which imitates under the waves the pretty nests of the birds."

The family of *Siluridæ* are especially notable for their nest-building habits. I have already mentioned the case of the *Glanis*. Agassiz speaks of another member of this same family. "Who can see the cat-fish (*Pimelodus catus*)," he asks, "move about with its young brood, or the sun-fish (*Pomotis vulgaris*) hovering over its eggs, and protecting them for weeks, without remaining satisfied that the feeling which prompts these acts is of the same kind with that which attaches the cow to its calf." The genus *Doras*, containing two species of nest-making fish, belongs to this same family of *Siluridæ*. In these instances both the male and female fish take part in the construction of the nest, and protection of the eggs and

* "Atque avium dulces nidos imitata sub undis." (line 122.)

young fry. The negroes of Demerara, where these *Hassars*, as they are called, are found, very readily catch the fish by putting their hands into the water near the nest, when the parent fish rushes furiously at them, and is thus captured. Dr. John Hancock, who has given an interesting account of these *Hassars*, one of which he calls the Flat-headed, the other the Round-headed Hassar, thus speaks of the nests:—"The Round-head forms its nest of grass, the Flat-head of leaves. Both at certain seasons burrow in the bank. They lay their eggs only in wet weather. I have been surprised to observe the sudden appearance of numerous nests in a morning after rain occurs, the spot being indicated by a bunch of froth, which appears on the surface of the water over the nest. Below this are the eggs, placed on a bunch of fallen leaves, or grass, if it be the littoral species, which they cut and collect together. By what means this is effected seems rather mysterious, as the species are destitute of cutting teeth. It may possibly be by the use of their serrator arms, which form the first ray of the pectoral fins." The *Callichthys*, another genus of this family, manifests the same care for its young.

The stickleback, the especial subject of this paper, is the three-spined species (*Gasterosteus aculeatus*, Lin.). Yarrell enumerates several species of this fish, but Mr. Couch* regards most of these as mere varieties, and recognizes only three species, viz., the one just named, the ten-spined (*G. pungitius*, Lin.), and the fifteen-spined stickleback (*G. Spinachia*, Lin.), a species entirely marine. All these, I believe, are nest-builders. There is no doubt whatever about two of them, for the nests of both have been seen by several observers, but I cannot call to mind at present any notice of the nest of *G. pungitius*. This species is not uncommon in ditches, and I have often found specimens, but hitherto have searched in vain for their nests. The three-spined sticklebacks are inhabitants of both salt water and fresh. Mr. Couch, one of our best authorities on all that relates to the habits of fish, remarks that "they do not in preference frequent the open sea, and that a quiet union of the sea water with the fresh appears the most congenial with their nature—as we may judge by the abundance to be met with in such situations." The same author states that so numerous are they, that "in some places they are employed for the purpose of feeding ducks and pigs; and sometimes they are drawn on shore in such heaps as to serve for manure, for which purpose they are said to be of considerable value—a fact not improbable, when, according to Lacépède, they are known to afford, by pressure, a good supply

* *Fishes of the British Isles*, i. pp. 167—184. Groombridge and Sons.

of oil, which we suppose can come only [chiefly?] from the liver." I am able to mention another use to which our little stickleback friends are applied. A friend of mine, whilst partaking of a dish of whitebait, was surprised to find the presence of certain very sharp spines in that said much appreciated dainty. Lo, there they were sticking in his tongue and between his teeth! He brought a bottle of whitebait home, in which three or four sticklebacks were readily recognized.

RESULTS OF METEOROLOGICAL OBSERVATIONS MADE AT THE KEW OBSERVATORY.

LATITUDE 51° 28′ 6″ N., LONGITUDE 0° 18′ 47″ W.

BY G. M. WHIPPLE.

1865.	Reduced to mean of day.					Temperature of Air.			At 9·30 A.M., 2·30 P.M., and 5 P.M. respectively.		Rain—read at 9·30 A.M.
Day of Month.	Barometer, corrected to Temp. 32°*	Temperature of Air.	Calculated. Dew Point.	Calculated. Relative Humidity.	Calculated. Tension of Vapour.	Maximum, read at 9·30 A.M. on the following day.	Minimum, read at 9·30 A.M.	Daily Range.	Proportion of Sky clouded.	Direction of Wind.	
	inches.	°	°		inch.	°	°	°	0—10		inches.
Jan. 1	...	...	...	...	...	36·3	31·4	4·9	...	... ...	0·000
„ 2	29·724	30·7	29·2	·95	·190	36·4	21·4	15·0	10, 10, 10	—, SSE, SE by S.	·091
„ 3	29·648	32·9	30·9	·93	·206	34·8	23·9	10·9	10, 8, 10	N, NW by N, NW.	
„ 4	29·907	44·3	38·9	·83	·307	49·4	28·8	20·6	8, 9, 0	WSW, W, SW.	·000
„ 5	30·011	43·4	43·1	·99	·297	49·1	36·5	12·6	7, 10, 10	W by S, S, SW.	·000
„ 6	30·034	40·1	37·8	·92	·265	42·5	38·9	13·6	0, 7, 3	W, WNW, W by S.	·223
„ 7	30·313	37·4	33·0	·85	·241	44·0	31·2	12·8	6, 0, 4	SW, WSW, SW.	·000
„ 8	...	...	...	...	...	46·1	32·5	13·6	...	... ...	·002
„ 9	29·813	42·2	36·1	·81	·285	45·7	37·7	8·0	0, 10, 10	SW, W by S, SW.	·010
„ 10	29·773	47·9	44·3	·88	·347	49·7	39·4	10·3	9, 10, 10	SW by S, SW by S, SW.	·002
„ 11	29·723	43·2	41·1	·93	·295	46·8	41·2	5·6	8, 8, 10	SW by S, SSW, S by W.	·046
„ 12	29·110	43·8	39·4	·85	·301	47·5	42·4	5·1	10, 7, 6	S by E, SW by S, SSW.	·043
„ 13	29·112	36·6	31·9	·85	·234	46·2	32·0	14·2	0, 8, 10	WSW, SW by S, S by W.	†·780
„ 14	28·697	42·9	33·9	·73	·292	46·1	34·7	11·4	10, 10, 4	SW, W by N, W by N.	·402
„ 15	...	...	...	...	...	42·0	37·9	4·1	...	... ...	·045
„ 16	28·979	37·7	33·1	·85	·244	40·6	34·0	6·6	6, 7, 4	WSW, NW, SW.	·000
„ 17	29·189	34·2	29·7	·85	·215	38·0	32·0	6·0	1, 5, 0	SW by W, NW, NW by W.	·005
„ 18	29·335	34·9	32·0	·90	·221	37·7	30·0	7·7	8, 10, 10	—, W, WSW.	·015
„ 19	29·459	34·9	33·1	·94	·221	36·4	33·0	3·4	10, 10, 10	—, N by W, NW by N.	·010
„ 20	29·591	34·0	30·0	·87	·214	37·8	31·2	6·6	7, 4, 0	WSW, S by W, W.	·000
„ 21	29·635	29·0	28·2	·97	·179	37·9	21·5	16·4	8, 7, 10	—, —, —.	·000
„ 22	...	...	...	...	...	33·6	22·2	11·4	...	... ...	·000
„ 23	29·805	32·3	28·8	·88	·201	36·2	25·4	10·8	1, 6, 8	SW by S, SE, E by S.	·000
„ 24	29·613	34·2	28·7	·83	·215	35·9	28·6	7·3	10, 10, 10	NE, NE by E, ENE.	·000
„ 25	29·661	32·8	28·1	·84	·205	34·1	32·2	1·9	10, 10, 10	NE, NE by E, E by N.	·049
„ 26	29·301	33·1	32·8	·99	·207	34·8	32·0	2·8	10, 10, 10	E by N, NE by E, ENE.	†·164
„ 27	29·158	32·3	31·0	·95	·201	33·8	32·5	1·3	10, 10, 10	NNE, N, NNW.	†·732
„ 28	29·910	30·7	21·8	·73	·190	35·4	25·8	9·6	0, 0, 0	WNW, W by S, WSW.	†·264
„ 29	...	...	...	...	...	36·1	16·7	19·4	...	... ...	·000
„ 30	29·267	36·9	35·5	·95	·237	39·8	21·6	18·2	10, 6, 10	E, SE by E, —.	†·188
„ 31	29·179	39·8	38·3	·95	·262	43·7	34·5	9·2	6, 10, 10	S by W, SSE, SSE.	·027
Daily Means.	29·536	37·0	33·5	·89	·241	...	...	9·7	...	... ...	3·098

* To obtain the Barometric pressure at the sea-level these numbers must be increased by ·037 inch. † Rain and melted snow.

HOURLY MOVEMENT OF THE WIND (IN MILES) AS RECORDED BY ROBINSON'S ANEMOMETER.—JANUARY, 1865.

Day.		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	Hourly Means.
Hour.																																	
12		8	1	9		11	24	11	8	12	20	9	17	5	19	22	10	3	6	4	7	3	2	4	17	10	13	14	18	3	12	7	10·3
1	A.M.	13	3	8		11	22	10	10	11	22	8	20	4	8	19	13	3	5	6	5	3	5	2	17	10	13	15	15	4	14	5	10·1
2		8	2	4		11	18	9	11	10	20	7	20	6	9	20	15	5	5	5	5	2	6	5	20	12	12	14	15	1	15	5	9·9
3		15	1	1		12	26		15	13	20	5	20	6	15	18	14	7	5	5	3	2	8	3	23	12	13	18	13	2	16	3	10·8
4		11	2	3	123	10	32		20	12	20	5	20	4	33	25	14	9	4	4	4	0	6	4	25	9	13	16	13	1	18	7	11·9
5		9	2	4		10	27		12	8	22	4	25	6	20	21	11	10	5	2	5	1	5	3	21	10	17	16	12	1	16	4	10·7
6		10	0	7		10	23	40	10	10	20	2	25	10	24	22	11	9	5	3	4	2	6	3	15	9	20	17	14	1	17	5	10·8
7		10	2	8		11	28		9	11	18	6	29	12	23	18	10	9	4	3	5	1	7	2	19	2	23	19	14	1	12	4	11·0
8		10	1	5		12	20		8	9	17	5	41	12	28	13	10	6	6	2	5	0	6	5	18	8	17	20	11	1	12	4	10·8
9		12	1	10		12	20		9	9	18	7	34	9	36	12	9	5	5	1	3	1	3	4	11	6	16	23	8	1	10	5	10·3
10		14	1	11	12	10	25	8	14	15	26	7	35	12	31	16	12	8	4	0	7	0	4	2	15	9	12	22	10	5	5	10	11·7
11		13	1	9	11	13	28	10	11	17	24	11	35	14	29	18	13	4	7	3	9	2	7	5	15	11	12	20	11	6	5	10	12·4
12		15	6	6	19	10	29	12	17	16	25	14	29	16	33	18	13	9	6	4	7	3	8	2	11	13	11	20	10	10	3	11	13·1
1	P.M.	16	9	5	15	7	24	14	11	17	26	10	33	15	33	19	14	6	6	3	8	3	8	2	14	10	13	18	6	11	4	10	12·6
2		17	9	4	15	5	22	13	15	17	23	12	29	14	35	17	13	6	7	4	7	1	10	2	15	12	13	18	9	11	5	14	12·7
3		12	10	5	9	6	19	11	16	16	22	8	24	16	33	13	18	8	5	3	5	2	6	5	15	13	11	21	6	12	4	14	11·9
4		11	6	5	7	19	18	9	18	16	27	6	22	19	35	11	5	3	5	7	5	5	6	5	14	15	10	21	5	10	4	15	11·7
5		10	10	4	7	18	15	10	13	16	25	4	22	20	23	11	6	4	3	7	4	2	3	6	16	15	15	19	5	12	4	14	11·1
6		12	8	5	9	16	14	10	20	18	26	9	12	31	27	17	7	4	5	7	3	2	3	7	13	15	15	19	6	16	3	17	12·1
7		12	9	6	10	17	16	10	19	20	24	11	19	34	19	15	5	4	5	5	4	3	8	13	12	15	21	7	19	4	16	12·5
8		7	11	8	12	19	13	12	20	22	12	11	15	24	23	11	6	5	5	7	5	2	4	8	13	8	17	21	6	19	2	10	11·5
9		6	12	5	9	20	15	9	18	24	10	15	14	20	22	10	8	4	6	4	4	4	5	9	12	9	17	20	6	17	2	7	11·1
10		4	14	7	12	23	15	9	19	22	8	19	5	20	25	11	7	4	7	5	5	4	5	11	9	9	16	16	7	21	4	12	11·4
11		2	16	5	10	20	15	9	13	22	8	16	11	19	20	13	4	3	6	2	3	4	4	13	11	13	14	15	5	16	4	11	10·5
12																																	
Total Daily Movement.		257	137	144	280	313	508	216	336	363	483	212	556	348	603	390	248	138	126	96	123	53	130	120	372	252	348	443	232	201	195	220	11·3

RESULTS OF METEOROLOGICAL OBSERVATIONS MADE AT THE KEW OBSERVATORY.

LATITUDE 51° 28′ 6″ N., LONGITUDE 0° 18′ 47″ W.

1865.	Reduced to mean of day.					Temperature of Air.			At 9·30 A.M., 2.30 P.M., and 5 P.M., respectively.		
			Calculated.								
Day of Month.	Barometer, corrected to Temp. 32°.*	Temperature of Air.	Dew Point.	Relative Humidity.	Tension of Vapour.	Maximum, read at 9·30 A.M. on the following day.	Minimum, read at 9·30 A.M.	Daily Range.	Proportion of Sky clouded.	Direction of Wind.	Rain—read at 9.30 A.M.
	inches.	°	°		inch.	°	°	°	0—10		inches.
Feb. 1	28·861	42·5	39·3	·89	·288	48·8	34·1	14·7	10, 9, 10	—, SW by S, SW by S.	0·213
„ 2	29·117	45·4	42·3	·90	·319	50·5	37·2	13·3	8, 10, 8	SW, SW, SW.	·021
„ 3	29·186	41·7	39·7	·93	·280	46·2	39·3	6·9	10, 7, 10	E, SE by E, —	·075
„ 4	29·558	33·7	32·3	·95	·212	36·3	35·8	0·5	10, 10, 10	ENE, E by N, ESE.	·001
„ 5	...	...	...	...	...	37·6	31·9	5·7	...	... ...	·000
„ 6	29·960	36·7	36·4	·99	·235	39·9	33·6	6·3	10, 10, 10	W, SSW, SSE.	·100
„ 7	29·821	45·9	44·5	·96	·324	49·4	36·2	13·2	10, 10, 10	SSW, SW, SSE.	·050
„ 8	29·951	35·6	29·1	·80	·226	39·7	36·9	2·8	10, 10, 10	N, NE by N, NNE.	·108
„ 9	30·339	33·8	22·6	·67	·212	38.0	31·2	6·8	1, 5, 4	NNE, NE by N, NE by N.	·002
„ 10	30·571	32·3	25·2	·78	·201	36·0	30·3	5·7	10, 9, 8	NE, NNE, NNW.	·000
„ 11	30·553	24·5	22·7	·94	·152	29·9	25·2	4·7	10, 7	ESE, ESE.	·012†
„ 12	...	...	...	...	...	33·2	24·3	8·9	...	... ...	·000
„ 13	30·211	25·0	21·9	·89	·155	28·7	23·5	5·2	10, 10, 10	E, NE by E, NE.	·049†
„ 14	30·205	27·3	22·9	·85	·168	30·2	23·5	6·7	10, 10, 10	NE by E, E, E.	·000
„ 15	29·920	27·1	21·0	·80	·167	30·8	16·3	14·5	10, 0, 7	—, ENE, W by N.	·000
„ 16	29·378	30·5	28·6	·93	·189	40·0	17·8	22·2	10, 10, 10	—, E by N, E.	·000
„ 17	29·363	34·0	28·5	·82	·214	38·4	28·9	9·5	0, 10, 5	WNW, SSW, SW.	·422†
„ 18	29·637	39·0	34·4	·85	·255	45·4	31·2	14·2	0, 10, 9	SW, SW by S, SW by W.	·013
„ 19	...	...	...	...	...	42·3	36·5	5·8	...	... ...	·073
„ 20	30·128	32·3	20·0	·64	·201	36·4	29·0	7·4	0, 0, 0	NW by W, NW by W, NW by N.	·013†
„ 21	30·254	30·5	28·3	·92	·189	33·8	27·6	5·2	10, 10, 10	W, S by E, S.	·000
„ 22	30·273	38·3	38·1	·99	·249	42·6	30·9	11·7	10, 10, 10	SW, SW, SSW.	·095
„ 23	30·300	46·6	43·3	·89	·332	50·7	35·7	15·0	9, 10, 10	W by N, SW, SW by W.	·030
„ 24	29·668	42·3	37·2	·83	·286	46·8	43·2	3·6	10, 10, 9	SW by S, N by W, NW.	·138
„ 25	30·192	42·4	34·2	·75	·287	47·1	34·5	12·6	0, 9, 10	NW by W, NNW,—	·367
„ 26	...	...	...	...	...	46·1	35·1	11·0	...	... ...	·030
„ 27	30·122	42·6	35·7	·79	·289	47·2	38·6	8·6	8, 9, 10	—, SW by S, S.	·131
„ 28	29·546	47·0	38·5	·75	·337	50·9	41·1	9·8	10, 9, 3	SW, W, W.	·002
Daily Means.	29·880	36·5	32·0	·85	·240	...	...	9·0	...	... ...	1·945

* To obtain the Barometric pressure at the sea-level these numbers must be increased by ·037 inch.
† Rain and melted snow.

HOURLY MOVEMENT OF THE WIND (IN MILES) AS RECORDED BY ROBINSON'S ANEMOMETER.—Feb., 1865.

Day.		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	Hourly Means.
Hour.																														
12		8	16	6	3	12	6	13	6	5	20	7	6	17	14	4	5	11	16	30	27	15	1	3	22	8	5	10	13	11·0
1		4	14	1	3	11	5	16	6	4	20	7	7	20	12	3	4	15	15	30	19	14	0	5	22	7	5	9	14	10·4
2		3	13	5	2	10	1	15	10	9	19	6	8	19	11	1	2	12	16	27	18	11	1	5	25	8	5	19	17	10·6
3		4	15	4	9	9	2	15	12	12	15	8	10	21	13	3	4	13	13	20	20	13	1	6	26	7	4	12	21	11·1
4		7	17	5	11	12	1	21	11	16	12	19	9	23	12	1	1	15	15	23	22	12	1	7	24	6	5	9	23	12·1
5		8	18	6	10	11	2	16	13	12	14	18	7	19	12	2	4	19	13	20	20	8	2	9	21	5	6	7	22	11·6
6		3	16	9	15	15	3	15	9	12	9	15	8	16	12	0	5	16	11	22	16	6	2	7	23	6	11	5	21	11·0
7		1	16	1	14	11	5	14	4	13	9	14	5	12	9	1	5	17	10	20	20	6	2	9	24	6	8	2	20	9·9
8		2	16	2	13	12	3	11	9	17	11	7	8	16	12	2	4	17	11	21	22	6	5	8	24	4	12	1	19	10·5
9		2	15	2	13	10	4	12	10	18	9	8	10	15	10	3	1	18	10	22	26	8	4	9	23	6	16	2	18	10·9
10		6	19	4	16	12	2	11	15	23	12	12	16	13	16	3	4	16	13	33	27	12	6	11	20	12	16	4	28	13·6
11		9	17	8	15	9	5	13	15	12	11	6	15	12	18	2	5	16	15	33	28	9	4	10	18	10	16	4	22	12·8
12		13	14	5	13	6	6	12	18	25	14	4	14	12	19	1	7	13	15	36	25	8	6	10	14	12	20	2	22	13·1
1		12	13	4	13	7	8	13	22	20	15	2	16	16	21	3	11	17	14	33	28	8	6	8	18	11	21	3	21	13·7
2		13	13	1	11	8	5	11	22	23	13	2	17	18	20	5	13	15	15	38	29	7	5	7	14	6	23	10	20	13·7
3		14	14	0	17	6	6	10	18	20	8	4	19	21	18	5	15	19	18	43	23	9	5	12	11	2	24	12	19	14·0
4		12	12	0	15	9	7	8	19	19	7	4	20	15	18	3	17	23	17	39	21	7	7	9	15	5	20	9	19	13·4
5		11	11	5	20	9	7	5	18	15	5	4	18	15	14	7	11	16	20	30	17	4	4	11	13	2	18	9	16	12·0
6		12	10	4	17	10	6	6	15	13	6	4	19	15	13	4	7	15	18	27	19	2	4	12	11	2	14	11	14	11·1
7		13	9	4	16	7	8	5	17	10	4	5	19	15	9	6	7	17	26	28	17	2	5	13	8	3	13	12	15	11·2
8		13	10	4	15	9	7	7	16	9	2	6	12	13	9	5	8	15	26	26	16	0	2	11	11	4	9	15	18	10·8
9		14	7	3	14	5	10	10	15	11	5	12	19	11	9	6	10	12	28	26	16	1	3	15	9	5	7	13	18	11·2
10		16	8	2	13	5	13	9	12	12	7	11	19	12	8	3	11	13	28	26	17	1	5	16	10	5	6	16	18	11·5
11		15	5	5	12	8	12	9	5	15	6	11	22	12	8	4	9	15	27	25	14	1	5	21	5	4	5	13	17	11·1
12																														
Total Daily Movement.		215	318	90	300	223	134	277	317	345	253	196	323	378	317	77	170	375	410	678	587	170	86	234	411	146	289	209	455	11·8

RESULTS OF METEOROLOGICAL OBSERVATIONS MADE AT THE KEW OBSERVATORY.

LATITUDE 51° 28′ 6″ N., LONGITUDE 0° 18′ 47″ W.

1865. Day of Month.	Reduced to mean of day.					Temperature of Air.			At 9·30 A.M., 2.30 P.M., and 5 P.M., respectively.		Rain—read at 9·30 A.M.
	Barometer, corrected to Temp. 32°.*	Temperature of Air.	Calculated.			Maximum, read at 9·30 A.M. on the following day.	Minimum, read at 9·30 A.M.	Daily Range.	Proportion of Sky clouded.	Direction of Wind.	
			Dew Point.	Relative Humidity.	Tension of Vapour.						
	inches.	°	°		inch.	°	°	°	0—10		inches.
Mar. 1	29·650	43·6	36·7	·79	·299	48·8	41·1	7·7	8, 8, 2	WNW, W, W by N.	0·012
„ 2	29·771	42·1	34·6	·77	·284	48·3	40·8	7·5	10, 4, 3	SW by W, W by N, NWbyW	·110
„ 3	30·296	39·9	30·2	·71	·263	47·2	33·8	13·4	10, 6, 3	W by N, W by S, NW by W.	·011
„ 4	30·061	39·0	34·4	·85	·255	45·8	28·4	17·4	10, 9, 9	SW by S, SW by S, S.	·003
„ 5	...	...	...	...	...	45·2	32·2	13·0	...	...	·170
„ 6	29·249	35·8	33·7	·92	·228	39·5	35·0	4·5	10, 10, 10	N by E, N by E, N.	·072
„ 7	29·617	37·6	28·7	·73	·243	43·3	33·3	10·0	7, 7, 8	NWbyW, NWbyN, NWbyW	·011
„ 8	29·688	36·0	28·2	·76	·229	40·9	28·8	12·1	10, 9, 4	NW, N, N by W.	·000
„ 9	29·941	36·5	26·1	·69	·234	43·2	34·1	9·1	3, 9, 3	N, N by W, N by W.	·000
„ 10	29·797	33·9	32·4	·94	·213	39·9	30·0	9·9	10, 10, 10	SW, SW, WSW.	·000
„ 11	29·751	36·8	34·2	·91	·236	42·9	35·6	7·3	7, 10, 10	N by E, N, N.	·111
„ 12	...	...	...	...	...	40·8	33·8	7·0	...	...	·045
„ 13	29·844	36·9	26·9	·70	·237	42·9	33·8	9·1	6, 7, 8	NW by N, E, ESE.	·014
„ 14	29·884	34·5	29·8	·85	·218	39·4	34·4	5·0	10, 9, 10	NE, NE, NNE.	·000
„ 15	30·035	34·1	28·3	·81	·215	38·5	32·9	5·6	10, 10, 10	NE by N, NNE, N by E.	·009
„ 16	30·020	35·1	27·0	·75	·222	40·1	33·1	7·0	10, 10, 8	NE by N, N, —.	·000
„ 17	29·923	37·0	29·7	·77	·238	43·6	30·3	13·3	10, 7, 9	ENE, E by S, SE.	·000
„ 18	29·993	33·7	30·4	·89	·212	39·3	29·5	9·8	10, 10, 10	E, E, E by N.	·000
„ 19	...	...	...	...	...	38·3	34·2	4·1	...	...	·000
„ 20	29·921	28·6	18·1	·68	·176	34·2	26·2	8·0	0, 0, 1	ENE, ENE, ENE.	·000
„ 21	29·993	31·7	22·0	·71	·197	38·3	23·3	15·0	0, 1, 8	NE, NE, NE by E.	·000
„ 22	29·937	36·1	25·5	·69	·230	42·7	28·5	14·2	2, 4, 3	N by W, NNW, NW.	·000
„ 23	29·829	36·2	27·5	·74	·231	41·7	30·4	11·3	6, 7, 9	NW by W, N, NW.	·000
„ 24	29·810	35·6	26·6	·73	·226	41·8	28·0	13·8	0, 2, 7	N by W, NW by N, NNW.	·000
„ 25	29·675	34·9	29·9	·84	·221	42·8	26·0	16·8	2, 10, 10	SW by W, SW, SW.	·000
„ 26	...	...	...	...	...	38·9	34·0	4·9	...	...	·000
„ 27	30·023	34·7	23·3	·66	·219	40·6	27·2	13·4	2, 6, 5	NNE, N by E, NW.	†·177
„ 28	30·058	35·9	29·2	·79	·229	42·5	26·0	16·5	0, 10, 10	SSE, SSW, ESE.	†·014
„ 29	30·040	33·1	28·7	·86	·207	37·6	29·5	8·1	10, 10, 10	ESE, SSE, SSE.	·000
„ 30	30·254	39·9	28·5	·67	·263	45·9	30·0	15·9	0, 5, 6	W by N, N by W, —.	†·049
„ 31	30·164	45·0	39·3	·82	·314	53·3	30·0	23·3	0, 10, 10	WSW, W, WSW.	·002
Daily Means.	29·897	36·4	29·2	·78	·235	...	...	10·8	...	...	·000
											0·810

* To obtain the Barometric pressure at the sea-level these numbers must be increased by ·037 inch.
† Rain and melted snow.

HOURLY MOVEMENT OF THE WIND (IN MILES) AS RECORDED BY ROBINSON'S ANEMOMETER.—March, 1865.

Day.		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	Hourly Means.
Hour.																																	
12		21	6	14	4	20	6	10	2	18	6	17	9	2	7	17	1	3	3	27	32	28	5	8	5	6	12	15	0	4	3	1	10·1
1		20	10	11	5	10	8	10	1	17	5	16	7	2	10	13	1	3	3	27	35	30	6	7	8	5	17	13	2	5	3	2	10·1
2		17	9	6	4	5	9	4	1	18	7	17	9	3	12	15	2	4	1	28	33	23	6	6	3	4	14	15	3	5	2	2	9·3
3		16	6	8	4	3	9	7	2	16	4	16	8	2	12	13	1	6	3	29	33	19	9	8	3	4	13	13	3	6	1	2	9·0
4		16	7	7	3	6	7	9	4	19	4	19	7	5	11	17	2	12	2	33	37	20	6	6	7	3	13	11	3	5	1	1	9·8
5		39	8	10	3	7	4	9	8	17	3	20	10	3	12	12	1	10	7	33	41	20	9	7	5	6	12	10	4	5	0	1	10·8
6		11	7	11	1	7	3	11	7	17	5	18	9	2	13	11	1	10	10	26	38	14	10	8	4	7	15	10	3	6	2	4	9·7
7		11	10	12	3	9	2	12	8	18	7	20	10	3	14	10	1	12	10	29	44	17	10	6	4	7	16	13	3	5	0	5	10·7
8		18	11	10	2	10	3	16	8	19	7	20	10	2	17	10	1	10	9	25	50	22	18	8	8	8	11	15	5	5	4	6	11·9
9		17	9	11	6	18	5	15	11	18	8	22	12	3	18	12	6	13	7	32	47	20	21	11	14	11	20	15	6	9	4	5	13·7
10		15	15	11	15	22	10	16	14	22	12	27	14	2	20	12	6	8	16	38	37	17	24	11	17	16	23	19	8	7	8	7	15·8
11		18	15	12	20	21	13	12	19	22	16	30	13	5	18	14	7	9	20	42	39	17	23	12	16	19	26	16	10	11	7	9	17·1
12		19	15	15	25	19	15	15	20	23	16	30	13	6	21	10	8	11	20	47	44	16	22	14	14	20	28	17	12	11	7	14	18·3
1		20	23	18	27	21	18	13	20	23	21	22	12	3	21	10	3	13	22	40	52	17	22	10	8	22	29	15	7	8	9	11	18·1
2		19	27	16	27	19	16	13	19	22	19	27	11	3	17	9	4	11	25	44	46	17	22	10	17	20	27	15	11	6	7	10	17·9
3		21	28	13	29	20	19	11	19	18	20	20	9	1	21	8	3	14	20	41	47	15	19	13	15	21	30	14	10	8	7	10	17·5
4		23	27	8	26	16	19	9	15	17	16	22	4	3	23	8	1	9	26	44	50	18	17	10	8	22	32	12	9	5	7	6	16·5
5		13	23	9	26	16	15	9	14	15	16	21	1	7	29	6	4	5	26	41	37	14	17	12	8	17	26	7	9	5	2	6	14·7
6		13	23	5	26	14	16	2	8	16	15	16	3	10	20	5	3	7	27	42	35	15	9	10	5	16	26	2	7	6	1	8	13·3
7		9	24	2	30	10	11	3	9	17	10	17	2	9	16	5	4	6	28	43	30	8	7	9	6	17	27	3	4	7	2	6	12·3
8		13	18	3	31	10	10	2	9	13	16	16	2	9	18	1	4	2	27	35	24	8	8	9	3	17	22	2	4	8	1	7	11·4
9		11	23	3	33	9	10	1	15	12	16	12	3	7	16	3	4	3	25	36	24	9	6	7	3	19	17	1	3	10	2	8	11·3
10		8	20	2	30	12	5	3	19	13	16	11	4	7	16	1	3	6	24	35	20	9	6	8	5	17	18	1	3	10	3	7	11·0
11		10	16	3	25	8	10	2	17	11	14	11	2	7	14	1	2	7	27	32	27	6	9	3	7	11	16	3	5	8	1	8	10·4
12																																	
Total Daily Movement.		398	380	220	405	312	243	214	269	421	279	467	184	106	396	223	73	194	388	849	902	399	311	213	193	315	490	257	134	165	84	146	13·0

SECCHI AND FAYE ON THE SUN.—OBSERVATIONS BY CHACORNAC.

M. Faye communicates to the French Academy* a letter received by him from Father Secchi of the Roman Observatory, on the constitution of the sun, and we proceed to extract the most important remarks in the epistle of the former, and the comments of the latter.

Father Secchi considers that Carrington's researches indicate the sun to be either altogether fluid, or, at any rate, much more so than might have been expected from the tenuity of his photosphere, or luminous envelope; and from this state of things he conceives a strong and permanent supply of heat may arise through the caloric disengaged by matter passing from the liquid to the crystalline or vesicular condition, and also from the heat disengaged in processes of dissociation, such as we have explained in former numbers detailing the experiments of St. Claire Deville. He agrees with M. Faye that the sun's layer of transparent atmosphere may be regarded as of moderate thickness, but of considerable refractive power. Such a view would coincide with the observations of Mr. Carrington, who has shown systematic deviations in spots moving towards the sun's margin which might be due to solar refraction.

Father Secchi finds the bodies known as willow leaves or rice grains all over the sun's surface, but scattered and ranged in a convergent manner towards the centre of the nuclei of spots, and also in the contour of the penumbræ and in their interior, giving rise to the well known serrated appearance.

Recently he observed a bright white line which divided a nucleus, break itself up into willow leaves on the grey bed of the penumbra. Viewed from any point in the sun the willow leaves must have enormous dimensions, far exceeding those of the cumulus clouds that float in our atmosphere. But our cumuli have rounded forms, while the objects in the sun are elongated. Can this, he asks, result from the movement of transport towards the centre of the spots and from the tendency to fill them up? He thinks that inquiry into the constitution of other bodies may elucidate the phenomena of the sun, and he confirms Mr. Huggins' discovery of the gaseous spectrum afforded by the Orion nebula.

In commenting on Father Secchi's letter, M. Faye alludes to the labours of De la Rue, Balfour Stewart, and Loewy, which taken in conjunction with those of Carrington, confirm the opinions of Wilson and Herschel and justify his (M. Faye's)

* See *Comptes Rendus*, 1865, No. 10.

objections to the theory of the solar photosphere and spots put forth by Kirchhoff.

He cites an opinion of Secchi, that as in our atmosphere we have a substance—water—capable of transforming itself into a fine dust* and into a vesicular state, capable of suspension in clouds, so there may be in the solar atmosphere a quantity of material capable of assuming similar conditions at an elevated temperature.

These corpuscles would act like solid particles suspended in gases, and would exert, as Magnus has shown, a greater radiating power, both calorific and luminous, than the vapour in which they floated. This would explain why the spots, or places in which the clouds were torn and interrupted, radiated less light and heat, although their temperature might be the same.

If Kirchhoff was right in assuming that invisible layers of an immense atmosphere external to the photosphere absorbed certain solar rays, and thus produced the dark lines of the spectrum, we ought to obtain from that outer atmosphere, when its action could be isolated, a spectrum the exact converse of that afforded by the photosphere. In 1842, M. Fasinieri took advantage of a total eclipse to obtain this spectrum, and found it completely dark in the space usually occupied by the green. It was a discontinuous gaseous spectrum, and by no means the converse of a solar spectrum. Bearing in mind these facts, M. Faye thinks the absorption of certain rays may take place in the photosphere itself, a supposition which would require us to regard solar light as emanating not only from the surface of the photosphere, but as also coming from various depths. If the existence of a photosphere was preceded by a gaseous condition in which no solid matter existed, researches, like those of Mr. Huggins, may trace in other bodies the history of changes which the sun has undergone.

M. Faye observes that if the rice grains or willow leaves owe their elongated form to currents in the sun's atmosphere careful photographs made in the approaching period of the minimum spots and least disturbance may show a noticeable regularity in their direction. The disappearance of the rice grains from, and the appearance of willow leaves and straws in spots may, he thinks, be explained by supposing that in such places there are strong descending currents, which carry the bodies downwards and cause us to see them in elongated perspective.

He thinks the best photo-heliographs would be taken by presenting the glass to the sun with the collodion surface behind

* It is not correct to regard steam as water *dust* or fine spray.

and not in front. He likewise recommends a blackened paper to be placed behind the collodion film to absorb the light and prevent reflection.

OBSERVATIONS BY M. CHACORNAC.

We are indebted to M. Chacornac for a copy of *Bulletin des Observations faites à Ville-Urbanne*, on some groups of sun spots seen on the 6th March, 1865, at 9h. 0m. On this occasion the regions of the penumbræ exhibited a series of layers superposed in *echelon*. This appearance, M. Chacornac remarks, is not rare, but in this case it coincided with an analogous disposition of the interior strata, plunging down into the dark regions of the central body.

M. Chacornac observes that when spots close up it is nearly always possible to perceive in their depths *bridges*, which take the form of meshes of a net-work formed of a glutinous matter (*matière glutineuse*), the superficial layers corresponding with others at greater depths. In the spots seen at the above date "the meshes of the pasty matter (*corps pâteux*) lying beneath the photosphere had a stretched-out appearance, evidently arising from traction movements operating in different directions, either by the expansive force of the gas visibly escaping from the orifices, or by the fall of strata, which seemed to plunge towards the centre through the weakening of the strata that supported them; or perhaps by reason of movements of translation occurring in deep strata, and due to currents in a direction opposite to those of the upper layers. These phenomena show an evident relation between the pasty shell (*écorce*) and the liquid medium of the centre."

M. Chacornac refers the formation of spots to two sorts of actions. In the one he says it is like the enlargement of an originally-formed aperture by the escape of vapours from a pasty mass in fermentation. In the other it is as if the surface was engulphed at certain points in such a manner as to form an elevated margin, with a slope or *talus* more or less inclined to the solar surface. This configuration has the aspect of vent holes (*soupiraux*), having their axes inclined to a normal to the sun's surface.

When a large spot suddenly appears, the engulphing action takes place at all points of the circumference, and almost simultaneously. "The changes effected by the concurrence of the two kinds of action cause a dispersion of incandescence chiefly in a vertical direction, and the spot no longer exhibits a penumbra." When the engulphing action is rapid, it swallows up small adjacent spots, and the size of the chief one becomes enlarged. From the vicinity of several centres of activity,

lateral tractions and currents in opposite directions arise. "When we examine the structure of the body below the photosphere, we find that its appearance of being pierced with orifices, through which vapours are discharged, will account for the shapes usually taken by spots and by simple pores. If we follow the changes of the photospheric crystals deposited or situated on the sloping branches of bridges, like those of the 6th March spot, which plunge down into the dark cavity, we observe the following facts. When, by reason of the movements which transport large bodies into the depths of the crater, they (the photospheric crystals) are carried into the dark cavity—into the region of dissociation, if we may employ the term—they seem to evaporate and dissipate, after they have passed a certain limit, just as dappled atmospheric clouds behave under the influence of a warm current."

From the preceding passages, which we have given as literally as possible from M. Chacornac's paper, the reader will be prepared to learn that he regards the stratum below the photosphere as pierced with innumerable little craters, or vent-holes, through which vapours escape, and tear the luminous envelope to a greater or less extent. He considers that the region of most intense light does not extend beyond the faculæ; that below them is a less luminous region—that of the penumbræ—in which the same actions take place, but with less intensity.

Speaking of the appearance of "lines of dislocation," M. Chacornac observes, that at the beginning of the spots which form the chief subject of his remarks, "all the vent-holes (*soupiraux*) of the margin opened simultaneously, and arranged themselves in an arc of a great circle. Some hours later, some of these orifices were almost shut, and others considerably enlarged; but all were displaced so that the chain of them presented a sinuous line, as if the entire mass supporting the pasty outer layer (*écorce pâteux*) was influenced by currents varying in velocity according to their heliocentric latitude. Thus, in spite of relative displacement, the eruptive centres sensibly preserved their forms. Is not this a proof that the orifice of the crater is pierced through a medium of a certain consistence, and that the entire mass is displaced?"

In another passage, M. Chacornac speaks of having continuously watched spots which joined to others of larger dimensions by traversing a space of 17″ in three hours, while for three consecutive days he has seen a small spot remain without change of form on the margin of a large opening. There are thus periods during which the sun's outer layer (*écorce*) seems to be fused with a rapidity that manifests the

activity of a solar volcano, while at other times a volcano of large opening is comparatively quiescent.

During the last two months (preceding 6th March), M. Chacornac has remarked that spots entering the visible hemisphere remained quiet while in the margin of the disc, became active as they progressed from the margin, and gradually closed after passing a particular central region. This action is, he observes, in conformity with the remarks of the President of our Astronomical Society concerning the action of the planet Venus.*

With regard to faculæ, M. Chacornac observes, that notwithstanding what he has recently written, "it is certain that they arrange themselves in long trains converging towards an active centre of eruption, like immense rivers suddenly formed and proceeding directly or by branches from all directions. It is no longer doubtful, from the nature of their configuration, considered with reference to the solar volcanoes, that they are currents of photospheric matter pouring themselves continually into the cavity of a spot, whose intermittent eruptions continually disperse them." He adds, that they have a tendency to form in the direction of meridians rather than of latitude parallels.

STAR COLOURS.

Few objects in the whole round of nature exercise a deeper fascination on the mind than coloured stars. Analogy leads us to regard each star as the centre of a system more or less resembling that aggregation of planets around a central sun, to which we belong. A single star of conspicuous colour invites us to speculate upon the effects its richly-tinted beams may have upon the animal and vegetable life that we conjecture lives and thrives upon the worlds revolving around it; and though astronomy, calling to her aid the kindred sciences of chemistry, botany, and biology, can afford but slender hints concerning the probable nature of the herbs that may cover the surface of distant globes, of the form and hue of the flowers that may adorn their changing seasons, of the trees that may compose their forests, or of the creatures that may luxuriate in their sunshine or their shade, still our fancy loves to picture the unknown scenes, and to cherish the hope that our spirits may one day be able to traverse the

* The President of the Society was speaking of the evidence on this subject obtained by the researches of Mr. Balfour Stewart.

fields of space, collecting knowledge as we wander from orb to orb.

If single stars of bright colour so strongly appeal to the imagination, binary, or more complex systems, in which the colours are contrasted, suggest more beautiful pictures, and prompt to more elaborate speculations. What, for example, must be the aspect of the skies of planets that may cluster round Albireo (β Cygni) and rejoice in the commingling or alternation of the sapphire and topaz beams. Somewhat similar inquiries are suggested by stars remarkable for rapid changes of hue; such, for example, as Capella, whose vivid chromatic flashings attract the most careless eye; or the strange portentous combinations and alternations of red and green that gleam from Antares, in Scorpio, when that extraordinary star is viewed through a telescope of moderate size. The first question that arises is, are the colours real attributes of the bodies that seem to emit them, or results of our terrestrial atmosphere, or of the tendency of the eye to be affected by accidental tints? The influence of our atmosphere, though in one sense a shifting quantity, is yet constant in another; and as the same star is seen at different seasons, and at different hours in different parts of the heavens, and at different elevations above the horizon, we can, by collating a number of observations, arrive at tolerably precise results; and we find that if we eliminate changes obviously belonging to the stars themselves, that the star colours retain a considerable amount of fixity, whether seen near the zenith, or at moderate heights above the horizon, and that weather changes of greater or less transparency only cause their appearances to differ, as might be expected from the optical effects of air in different states of dryness, moisture, motion, and homogeneity, or the reverse. Thus, whether Sirius was red or not to the ancients, it is a white star to us, though somewhat blueish, as M. Babinet* states, in towns, through the impurities of their air. Arcturus in like manner belongs to the yellow series, and Vega to those of pale sapphire tint. Star colours, then, are not made by our atmosphere, but only modified more or less, according to its condition at the time. Some portion of their colour is the result of the law of simultaneous contrast, which M. Chevreul has treated in his well-known work. Thus M. Babinet states that a deep blue sky has been observed to make Venus look of an orange complexion. Two stars of contrasted colours seen in the same telescopic field, and near each other, will heighten or modify each other's tints according to their relative intensities of the complimentary colours which

* See an interesting letter of M. Babinet to Admiral Smyth, in *Astronomical Register*, for April.

they induce our eyes to see. Thus, red and green will each look brighter and more decided when in simultaneous view. This source of colour would be sufficient to account for some stars appearing different from their real hues; but it may be eliminated by a bar or wire that keeps one star out of view while the other is seen. By such means the position and real character of star colours is assured, and we ask what do they proceed from?

This question will be better answered when we have made out a little more concerning our own sun. At present it seems as if the light of the sun and stars emanated from intensely heated vapours holding solid particles, hot enough to be luminous, in suspension. The carbon particles in common gas, as in the gaseous products of a oil lamp, have a yellowish tinge; molten silver is greenish, and the lime light tinged with blue. The atmosphere which probably surrounds the luminous matter of our sun, or of other suns, obstruct certain rays, as the dark lines of the spectrum show; but with this exception we probably see sunlight and starlight pretty much as it is emitted by the luminous matter, that is, within the limits of our sight, for we cannot perceive rays that exceed or fall short of a certain velocity in their vibration, or of a certain refrangibility.

An accumulation of facts, some of which have been recorded in the papers of Mr. Webb, and others of the same kind, which we leave for his abler pen to describe, have given a new interest to coloured stars, by showing that they are liable to alterations and changes, some of which appear periodical. The observation and due registration of these changes will afford a useful and delightful occupation for amateurs, and with a view to give precision to this class of inquirers, Admiral Smyth has proposed, in a privately issued work, called *Sidereal Chromatics*, a certain scale for comparison. He gives four tints, each diminishing in intensity, of red, orange, yellow, green, blue, and purple, leaving whites to be described, in the order of their purity and brightness, by the terms—1, creamy white; 2, silvery white; 3, pearl white; 4, pale white. A suggestion from Admiral Smyth is sure to be of value in itself, and to be well received by all astronomical observers, and we apprehend the only doubt that will arise will concern the method of employing his chromatic scale, and in this matter, with great deference for his opinion, we must profess a little disagreement, as we think it will be necessary to employ qualifying adjectives to a greater extent than he suggests. The more most coloured stars are looked at, the more will most observers be convinced that they are neither a simple tint of a primary or of a secondary colour, and in many cases the hue is of so much complexity as to render it difficult to say what it is.

Now in such cases a simple reference to tints, such as "red 3, blue 4," would, we think, be insufficient. If, for example, a number of observers, with different telescopes, assign a certain greenishness to the blue companion of Albireo, the fact should be recorded, and "blue 2" would require to be supplemented by an appropriate adjective. Admiral Smyth's tints appear to us admirably chosen for the purpose he has in view, and we should like to see them imitated in coloured solutions, or in coloured glass, which we think would be more convenient that flat tints on paper, as the light seen through transparent bodies affords a nearer approach to the luminous effect of stars.

We are glad to see by citations, which Admiral Smyth makes from Dawes, and other eminent authorities, that Horne and Thornthwaite's "aplanatic eye-pieces" are appreciated for these inquiries. We spoke highly of them on their first appearance, and prolonged trials have confirmed our good opinion.

There are many topics of importance in Admiral Smyth's work—which is a reprint, with additions, from his former publications—on which we abstain from commenting now, because we know they are engaging the attention of Mr. Webb, who will bring them forward in due time. We shall now only record our thanks to the Admiral for his new and important aid to the study of double stars, and conclude by wishing our telescopic subscribers to examine *Cor. Caroli*, and send us an account of the colours of the component stars, stating the size of the object-glass, sort of eye-piece, and power employed. Admiral Smyth gives a number of estimates of these colours, as they seemed to different eyes, and finally describes them himself as, A, pale reddish white; D, lilac: or in his scale, A, red 4, purple 3. We confess we should not have called it red, and shall be much interested in knowing and publishing what other observers see.

ON THE STRUCTURE, AFFINITIES, AND GEOLOGICAL POSITION OF EOZOON CANADENSE.

BY WILLIAM B. CARPENTER, M.D., F.R.S., F.L.S., F.G.S.

(*With Two Illustrations.*)

Among the communications made to the British Association at its recent meeting at Bath, there was certainly none of higher scientific interest than the announcement by Sir William Logan, the director of the Canadian Geological Survey, of the discovery of large masses of a fossil organism referable to the Foraminiferal type, near the base of the Laurentian series of rocks in North America. The geological position of this fossil, indicating the vast remoteness in time of its existence as a living organism, is scarcely more remarkable than its zoological relations; for, at what (so far as we at present know) was the dawn of animal life upon our globe, it affords evidence of a most extraordinary development of that Rhizopod type of animal life which now presents itself only in forms of comparative insignificance,—a development which enabled it to separate carbonate of lime from the ocean-waters, in quantity sufficient to produce masses rivalling in bulk and solidity those of the Stony Corals of later epochs, and thus to furnish (as there seems good reason to believe) the materials of those calcareous strata, of whose occurrence in the Laurentian series it had previously been impossible to give a satisfactory account.

Having been requested by Sir William Logan to verify the conclusions regarding the nature of this fossil which had been arrived at by Dr. Dawson of Montreal, and having been kindly supplied by him with ample materials for the further elucidation of its structure, I propose in the present paper to direct attention to the points of most striking interest, Geological as well as Zoological, which this discovery brings into view. And since the bare statement that the *Eozoon* occurs near the base of the Laurentian series of rocks, will not convey, save to such as have followed the most recent progress of geological research, any definite idea of the extraordinary interest that attaches to the marvellous glimpse which its presence there affords into the ancient life of our globe, I shall in the first instance take back my readers to that stage in the history of the science, which preceded the establishment of the "Silurian system" by Sir Roderick Murchison.

Geological Position of Eozoon.—Under the general designation "Primary Rocks" was formerly ranked an immense series of formations, some evidently stratified, others presumed to be non-stratified, chiefly originating in the disintegration of the

granite on which they rested, and consisting of gneiss, mica-schist, clay-slate, quartz, alum-shale, grauwacke, with occasional limestone beds. The older of these rocks were not supposed to contain any fossil remains; and from the indications they presented of changes in their condition subsequent to their original deposition, they were distinguished as *metamorphic*. In the newer strata, on the other hand, the presence of fossils had been recognized; but no such comparison had been made between these and the fossils of the Old Red Sandstone and Carboniferous Limestone (which were the oldest strata that had then been systematically studied), as threw any light on their mutual relations.

It was a little more than thirty years ago that Sir Roderick (then Mr.) Murchison was enabled, by the careful study of the order of superposition of the newer of these rocks in South Wales and along the Welsh border, to establish the existence of a regular series of strata, graduating downwards continuously from the lower beds of the Old Red Sandstone, and characterized by a distinct and peculiar assemblage of organic remains; and this series he designated the *Silurian system*, the region which had first revealed its existence being that once inhabited by the ancient Silures. The base of this series (which was marked out into Upper and Lower Silurian, both by a want of geological conformity and by differences in the fauna of the two divisions) was supposed to be formed by the hard beds of fissile sandstone largely developed near the town of Llandeilo in Carmarthenshire, and known as the "Llandeilo flags." These rest unconformably upon what was then designated the "Clay-slate" system; and it seems to have been at first assumed by the investigator of the Silurian system, that organic life had no existence on the globe previously to the epoch thus marked out.

But whilst Sir Roderick Murchison was thus working out in South Wales the later portion of the series of "primary rocks," Professor Sedgwick was applying himself with equal zeal and energy to the study of the older, as displayed in Cumberland and North Wales; and he succeeded in proving that whilst a regular order of superposition, broken however by many disturbances, may be traced through that massive series of slaty rocks of which a large proportion of the mountain ranges of Cumberland and North Wales are composed, the newer of these rocks present fossil remains in sufficient numbers to show that it was incorrect to assume the absence of life in those ancient seas. Thus a thick stratum of fissile sandstone underlying the "Tremadoc slates," which, again, lie beneath the Llandeilo flags, contains such a vast abundance of shells of the still existing genus *Lingula*, that this stratum

is known by the designation "Lingula-flags." For the whole series of stratified rocks underlying the original Silurian system of Sir R. Murchison, the names of *Cambrian* or *Cumbrian*, indicative of its special development in North Wales and Cumberland, were proposed by Professor Sedgwick; but geologists for some time hesitated in admitting it as a distinctly characterized group. The fossil types which it contained did not seem to differ so much from those of the Lower Silurian strata, as to justify the separation of the Cambrian from the Silurian fauna; and it was argued by Sir Roderick Murchison that there was more reason for carrying downwards the base of his Silurian system, so as to make it include the Lingula flags and the slates which intervene between it and the Llandeilo flags, than for admitting the existence of any pre-Silurian life. Even as late as 1851 we find so impartial and highly-qualified a judge as Sir Charles Lyell thus expressing himself on this point (*Manual of Elementary Geology*, 3rd ed., p. 361):—"Below the Silurian strata in North Wales, and in the region of the Cumberland Lakes, there are some slaty rocks devoid of organic remains, or in which a few obscure traces only of fossils have been detected, for which the names of Cambrian and Cumbrian have been proposed. Whether these will ever be entitled, by the specific distinctness of their fossils, to rank as independent groups, we have not yet sufficient data to determine."

The required data had been already furnished, however, by the labours of M. Barrande in Bohemia; in which country the older stratified rocks are developed even more remarkably than in Britain. Although scarcely more than twenty species of fossils had been previously obtained from this locality, M. Barrande had already acquired in 1850 no fewer than 1100 species; namely, 250 crustaceans (chiefly trilobites), 250 cephalopods, 160 gasteropods and pteropods, 130 acephalous mollusks, 210 brachiopods, and 110 corals and other fossils. This vast assemblage he found to comprise not merely the equivalents of the Upper and Lower Silurian fauna, but also a fauna clearly distinguishable from the latter, and designated by him "primordial," under the belief that it afforded evidence of the first appearance of life on this planet, and that consequently no fossiliferous strata of older date would or could ever be discovered;—an anticipation as vain as that which the founder of the Silurian system had entertained respecting the strata which he originally adopted as its base.

The peculiarity of the so-called "primordial fauna" specially consisted in the distinctness of its Trilobites from those of the Lower Silurian strata; not only the species, but even many of the genera, discovered by M. Barrande having been previously

unknown. And the occurrence of these generic types in strata very remote geographically, has served to identify them geologically; so that no doubt any longer remains that the Upper Cambrian rocks of North Wales, the alum-schists of Sweden, and the Potsdam sandstone of the United States (formerly ranking as the lowest member of the North American Silurians) with an underlying series of slaty rocks extending from New York to Newfoundland, belong to the same epoch as the Bohemian strata supposed by M. Barrande to present the earliest forms of organic life.

But below the Tremadoc slates and Lingula flags which constitute the *Upper* Cambrian, there is a vast series of sandstones and slates, known as "Harlech grits" and "Llanberis slates" (sometimes designated the "Longmynd" group, from being the components of the hills of that name in Shropshire), which constitute the *Lower* Cambrian series. The organic remains hitherto discovered in these are extremely scanty as regards number of *types*; consisting only of five species of Annelids and one obscure Crustacean form in the Harlech grits, and two species of the Zoophyte *Oldhamia* in the Irish equivalent of the Llanberis slates. But the number of *individual* Annelids whose remains are preserved is enormous; they are stated to occur in countless myriads through a mile in thickness in the Longmynd.

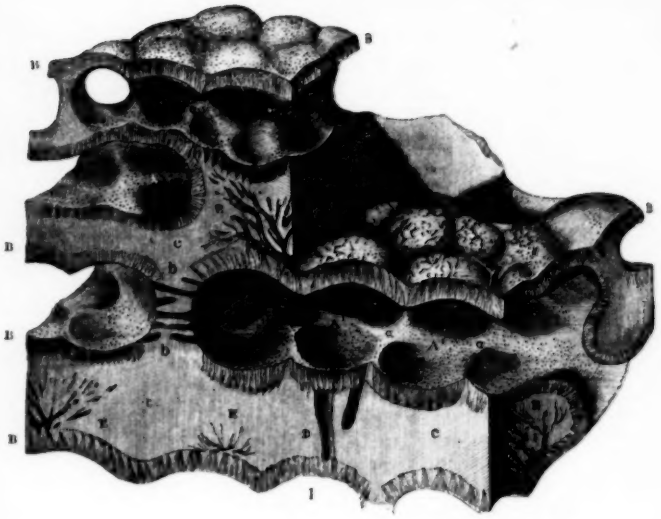
Of the immense lapse of time that must have been occupied in the deposit of the Cambrian strata, both the nature of their materials, which must have been derived from the disintegration of rocks of exceeding hardness, and their vast thickness afford ample evidence. The Tremadoc slates are estimated at 2000 feet, and the Lingula flags at 6000, making 8000 feet for the *Upper Cambrian*. Again, the Harlech grits present a thickness of from 6000 to 7000 feet, and the Llanberis slates about 3000, thus giving 10,000 feet as the thickness of the *Lower Cambrian*.* The labours of our Canadian geologists have brought to light a series of strata in the neighbourhood of Lake Huron, and thence designated *Huronian*, which are believed to be the equivalents of our Lower Cambrian, and which attain a thickness of not less than 18,000 feet. These consist chiefly of quartz-rock, with great masses of greenish chloritic slate, which sometimes include pebbles of crystalline rocks belonging to the still older Laurentian formation to be presently described. No organic remains have yet been discovered in this series, but beds of Limestone occur in it, one of them 300 feet in thickness; and as the

* The above figures are those given by Sir C. Lyell. By Professor Phillips the Longmynd strata are spoken of as "supposed to be 20,000 feet thick or more."

belief has been gradually gaining ground among geologists, that all limestones have been originally formed by the agency of Coral-polypes, Echinoderms, Mollusks, etc., which fix carbonate of lime from sea-water, just as plants fix carbon from the atmosphere, the mere fact of the occurrence of a limestone bed in strata otherwise non-fossiliferous, raises a presumption that organic life had not been wanting, even at that very early period. And it is to this epoch, represented in our own country by the Lower Cambrian strata, that one of our ablest and most experienced geologists, Professor Phillips, has recently assigned the origin of life on the earth.* He points out that in passing downwards through the Lower Palæozoic strata, the forms of life grow fewer and fewer, until in the lowest Cambrian rocks they vanish entirely, though these strata are of a kind such as might be expected to yield them. And the deficiency is not confined to the British types of the series; it is equally noticeable in their equivalents in North America, in Norway, and in Bohemia—countries well searched for this very purpose. "The absence is general; it seems due to a general cause. Is it not probable that during these very early periods the ocean and its sediments were nearly devoid of plants and animals, and in the earliest time of all, which is represented by sediments, quite deprived of such?" The following table is given by him as showing the marked reduction in number of types as we descend to the lowest beds of the Lower Silurian, and thence to the Upper Cambrian; this last reduction involving the entire loss of the representatives of a large proportion of the higher groups of mollusca. To complete the table we add a line, in which are noted all the types yet discovered in the Lower Cambrian.

		Amorphozoa	Foraminifera	Zoophyta	Echinodermata	Annelida	Crustacea	Polyzoa	Brachiopoda	Monomyaria	Dimyaria	Gasteropoda	Heteropoda	Pteropoda	Cephalopoda
Upper Silurian	Ludlow	...	1	10	17	18	39	1	30	17	41	27	4	4	30
	Wenlock	3	...	66	34	6	36	25	79	12	15	18	3	3	22
Middle Silurian	Llandovery	2	...	26	6	3	16	5	69	5	13	26	6	3	13
Lower Silurian	Caradoc	3	...	23	20	8	82	27	67	7	31	25	7	7	26
	Llandeilo	...	...	4	...	7	34	22	18	1	2	3	2	6	4
Upper Cambrian	Lingula	...	...	2?	...	2	11	1	3	...	...	...	...	...	...
Lower Cambrian	Longmynd	...	...	2	...	5	1	...	...	...	...	...	...	...	...

* *Life on the Earth; its Origin and Succession.* Cambridge, 1860.

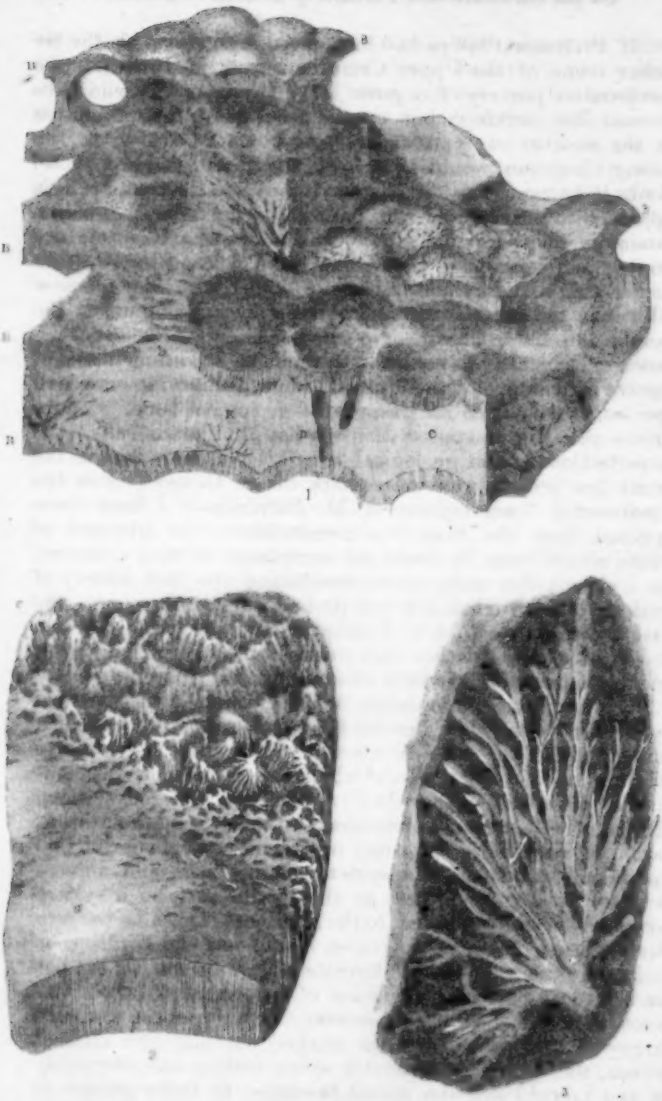


Structure of Eozoön.

If Professor Phillips had introduced into this table the far richer fauna of the Upper Cambrian strata in Bohemia, the comparative poverty of organic life in that epoch would have seemed less striking; but, on the other hand, the diminution in the number of types as we pass from the Upper to the Lower Cambrian, would have been still more obvious. "No doubt," he remarks, "it is open to any one to compare this approach to a Hypozoic zero with the reductions of life to a minimum above the Palæozoic, and above the Mesozoic deposits; and to *suppose* that below the Palæozoics *were* other earlier strata, and earlier systems of life, though they are now all lost in the general metamorphism which has produced the gneiss and mica schist. No one is likely to believe this, however, who attends seriously to the facts regarding the successive appearance of the classes, orders, families, genera, and species, as we search the records of geological time." More philosophical in its appreciation of what Mr. Darwin calls "the imperfection of the geological record," and more true as the event has proved, was the remark of Sir C. Lyell upon the "primordial" assumption of M. Barrande—"I have been opposed from the first to a nomenclature the adoption of which would seem to imply the acceptance of such a theory; for I always felt sure, on contemplating the past history of geology, that we had not yet pushed our inquiries into the past so far as to lead us to despair of extending our discoveries at some future day, when vast portions of the globe hitherto unexplored should have been thoroughly surveyed."

This sagacious anticipation has been marvellously verified by the discoveries which the excellent geologists of our Canadian survey, under the able direction of Sir William Logan, have recently made in the region of which the exploration was committed to them: for they have shown that the rocks which compose the Laurentian mountains in Canada, and the Adirondacks in New York, spreading over an area of about 200,000 square miles, belong to a system distinct from and antecedent to the Cambrian, just as the Cambrian form a system distinct from and antecedent to the Silurian.* These *Laurentian* strata consist chiefly of quartzose, aluminous, and argillaceous rocks, like the sedimentary deposits of less ancient times; but for the most part in a condition of *metamorphism* which has given them a crystalline character. By a break in the continuity of the strata they are marked out into two distinct groups, the Upper or Labrador series resting unconformably on the Lower; and the united thickness of these groups in Canada is certainly not less than 30,000 feet, and probably

* See the *Quarterly Journal of the Geological Society*, February, 1865, pp. 45—50.



Structure of Fossils.

If Professor Phillips had introduced into this table the far richer fauna of the Upper Cambrian strata in Bohemia, the comparative poverty of organic life in that epoch would have seemed less striking; but, on the other hand, the diminution in the number of types as we pass from the Upper to the Lower Cambrian, would have been still more obvious. "No doubt," he remarks, "it is open to any one to compare this approach to a Hypozoic zero with the reductions of life to a minimum above the Palæozoic, and above the Mesozoic deposits; and to *suppose* that below the Palæozoics *were* other earlier strata, and earlier systems of life, though they are now all lost in the general metamorphism which has produced the gneiss and mica schist. No one is likely to believe this, however, who attends seriously to the facts regarding the successive appearance of the classes, orders, families, genera, and species, as we search the records of geological time." More philosophical in its appreciation of what Mr. Darwin calls "the imperfection of the geological record," and more true as the event has proved, was the remark of Sir C. Lyell upon the "primordial" assumption of M. Barrande—"I have been opposed from the first to a nomenclature the adoption of which would seem to imply the acceptance of such a theory; for I always felt sure, on contemplating the past history of geology, that we had not yet pushed our inquiries into the past so far as to lead us to despair of extending our discoveries at some future day, when vast portions of the globe hitherto unexplored should have been thoroughly surveyed."

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much exceeds that vast amount.—The Lower part of the Laurentian series is represented in Scotland by the "fundamental gneiss" of Sir Roderick Murchison, which forms the whole of the island of Lewis, and on which, in various parts of the western highlands, the Lower Cambrian and various metamorphic rocks rest unconformably. The Upper, or Labrador group, seems to be represented by the Labradorite and Hypersthene rocks of Skye; which, though formerly supposed to be unstratified, correspond so closely with those of the Labrador series in Canada and New York as to leave no doubt that they belong, like the latter, to a regularly stratified system.—The "primitive gneiss" formation, again, which attains at least an equal thickness in Norway, has been shown to correspond with the Laurentian series of Canada; and the "primitive slate" formation which rests upon it is no less remarkably similar at once to the Huronian of Canada and to the Lower Cambrian of our own island.—The labours of Sir Roderick Murchison in Central Europe have shown that the ancient gneissic series of Bavaria and Bohemia, which underlies the "primordial zone" of Barrande, with a vast thickness of intervening clay-slate, corresponding to the Lower Cambrian, is the equivalent in position of the Laurentians of Canada and Scotland; and that, like them, it is divisible into an older and a newer series, the two together attaining the colossal thickness of 90,000 feet.

The following Table represents the general results of the inquiries whose history has been thus briefly sketched; showing the present state of our probable knowledge of the two vast series of stratified rocks, the Cambrian and the Laurentian, which underlie the Lower Silurian:—

GREAT BRITAIN.	NORTH AMERICA.	SCANDINAVIA.	CENTRAL EUROPE.
Upper Cambrian.	Potsdam Sandstone.	Alum-schists.	Primordial zone.
Lower Cambrian.	Huronian.	Primitive Slates.	Primitive Slates.
Hypersthene rock of Skye.	Upper Laurentian	Primitive Gneiss.	Primitive Gneiss.
Fundamental Gneiss.	Lower Laurentian		

"The united thickness of these three great series" (the Huronian and the Upper and Lower Laurentian), says Sir William Logan, "may possibly far surpass that of all the succeeding rocks, from the base of the Palæozoic series to the

present time. *We are thus carried back to a period so far remote, that the appearance of the so-called Primordial Fauna may be considered a comparatively modern event.*"

Clear evidence had been found in the constitution of the Laurentian and Huronian rocks, that the same chemical and mechanical processes which have ever since been at work in disintegrating and reconstructing the earth's crust, were then in operation; the great question remaining for determination was, whether *vital* activity had any place in those ancient seas, or whether they were altogether untenanted by living beings.

This question might be presumptively answered in the affirmative by two important sets of facts. In both the Upper and the Lower Laurentian series there are several zones of Limestone, each of sufficient volume to constitute an independent formation. The aggregate thickness of these is said by Dr. Bigsby to be not less than 5000 feet thick. Similar limestones occur in Scotland, and also in Norway and Finland, where they form beds of 1000 feet or more in thickness. Since these limestones are in a highly crystalline condition, the apparent absence of fossils in them could not be considered as in any way negativing the probability that they had been originally formed by the agency of animal life, and subsequently altered by metamorphic action—such being now universally admitted to have been the history of many newer limestones in which there is a like absence of any distinguishable organic remains. So, again, the occurrence of carbon—which, in the form of graphite, both constitutes distinct beds, and is disseminated through the calcareous or siliceous strata of the Laurentian series, as well in Norway as in Canada—might be taken as an evidence of the existence of vegetation during that epoch, since no one disputes the organic origin of this mineral in more recent rocks. Further, Sir William Logan had observed that certain of the Laurentian marbles, on being struck, gave forth the same overpowering smell of carburetted hydrogen, as is well known to be given off from many beds of carboniferous limestone, whose organic origin is most distinct. And Mr. Sterry Hunt, the accomplished mineralogist of the Canadian survey, had argued for the existence of organic matters on the earth's surface during the Laurentian period, from the presence of great beds of iron-ore, and from the occurrence of metallic sulphurets.

But however strong might be these presumptions, considered either separately or collectively, they could not be regarded as in themselves by any means sufficient to establish so important a conclusion, as the dating-back the commencement of organic life from the Lower Cambrian epoch, to the immeasurably more remote period during which

the Lower Laurentian strata were in process of formation. The needed proof has been supplied, however, by the discovery of the very remarkable fossil which it is my special object to describe; the *Eozoon Canadense* thus taking rank as by far the earliest form of animal life yet known, its development having been antecedent to the deposition of the greater part of the Laurentian series, nearly the whole thickness of which, with the Huronian in addition—amounting, as we have seen, in Canada to nearly 50,000 feet, and in Central Europe to 90,000—had been superimposed upon the lowest beds in which it occurs, before the epoch of the Lingula flags, which once, in the opinion of many geological authorities, marked the first appearance of life on our planet.

The history of this discovery is in itself not a little curious. Certain bodies presenting forms apparently organic were brought by Mr. J. McCulloch to Sir Wm. Logan, in 1858, from the Grand Calumet limestone on the river Ottawa; and these were found to be composed of alternating parallel or somewhat concentric layers of crystallized pyroxene and carbonate of lime. This alternation called to mind other specimens exhibiting a similar structure, which had some years previously been obtained, by Dr. Wilson, of Perth, from the Burgess limestone, but which had been regarded merely as minerals; their forms were the same as those of the Grand Calumet specimens, but their composition was different, the alternating layers being formed of Loganite (dark green silicate of magnesia) and Dolomite (magnesian limestone). Thus in both cases the alternation, though formed by different minerals, always consisted of *siliceous* and *calcareous* layers; and hence Sir William Logan, thinking it strange that identical forms should be derived from minerals of such different composition, was led to look upon them as fossils. As such they were exhibited by him at the meeting of the American Association for the Advancement of Science in 1859; and they were shown to some of his geological friends on this side of the Atlantic in 1862. One of the specimens had been sliced and submitted to microscopic examination; but unfortunately it was one of those composed of Loganite and Dolomite, in which minute structure rarely occurs; and in the absence of any evidence from this source, few except Professor Ramsay seemed disposed to believe in their organic nature.

The true character of these bodies thus remained in suspense until a little more than twelve months ago, when Sir Wm. Logan observed indications of similar forms in blocks of the Laurentian limestone from the Grenville bed, which is the highest of the three zones of limestone occurring in the Lower Laurentian series, and which attains, in some places, a

thickness of 1500 feet. These blocks had been brought to the Museum to be sawn into marble; and on being cut through, they were found to be composed of serpentine alternating with calc-spar. Thin slices of them having been prepared, distinct evidence of organic structure was observed in the very first specimen submitted to microscopic examination. The prosecution of the inquiry was confided to that experienced observer, Dr. Dawson, the accomplished Principal of M'Gill College, Montreal; and under the guidance of the figures and descriptions which I had given of the minute structure of various types of Foraminifera, in the series of Memoirs which had found a place in the *Philosophical Transactions*, and in my general *Introduction to the Study of the Foraminifera*, published by the Ray Society, he was led to the conclusion that this organism, notwithstanding its comparatively gigantic dimensions, belongs to the group of Foraminifera; being especially related to *Polytrema* in its zoophytic mode of growth, to *Carpenteria* in the imperfect separation of the cavity of its shell into distinct chambers, and to *Calcarina* in its canal-system. By Dr. Dawson and by Dr. Sterry Hunt it was further shown that the *calcareous* layers represent the original *shell*, which in the best preserved Grenville specimens has undergone very little change, but which in the Grand Calumet specimens has become crystalline, whilst in the Burgess specimens it has been completely metamorphosed by magnesian infiltration. On the other hand, they showed that the *siliceous* layers represent the original *sarcode-body* of the animal, which has been replaced by the infiltration of various silicates, as serpentine, pyroxene, and loganite—just as the sarcode-bodies of Foraminifera of various subsequent deposits, from the Silurian to the present time, have been replaced by the infiltration of glauconite and other siliceous minerals; enabling us to obtain, by the dissolution of their calcareous shells in dilute acids, most perfect *models* of the soft parts, exhibiting the forms and connections which they possessed in life, with far more truth and completeness than they could be determined by any other method of study.*

* The existence of such "internal casts" of the shells of *Foraminifera*—the models of the bodies which occupied them during life—in the Greensands of various Geological epochs, was first made known by Prof. Ehrenberg. Not long afterwards it was shown by Prof. Bailey, that the Foraminiferal shells of our existing seas are sometimes infiltrated in like manner; and many beautiful examples of this modelling process have been obtained by Messrs. Parker and Rupert Jones, to whose kindness I owe the "internal cast" of a recent *Polystomella*, of which I have given a figure in my description of that genus (*op. cit.*), and which was well designated by my friend Prof. Blanchard as a *bijou zoologique*. I certainly would not exchange it for a diamond of the same size, since it demonstrated the correctness of my account of the very complex arrangement which I had worked-out, before obtaining it, in the canal-system of the shell of that remarkable genus.

Such models were shown by the specimens recently brought over by Sir William Logan to be obtainable by submitting portions of *Eozoon* to the action of acid, so as to remove the calcareous shell; the siliceous infiltration having not merely filled the chambers, so as to give us the precise forms of the sarcodic segments which occupied them, but having also penetrated into the "canal system," which extends itself from these into the most solid and massive portions of the shell; and, as I shall presently show in addition, having actually taken the place of those wonderfully minute threads of sarcode which traversed the porous walls of the chambers, so as to stereotype (so to speak) their exquisitely beautiful brush-like arrangement, which is thus exhibited, in by far the oldest known fossil, with a perfection that could not be imitated by any means we possess of preparing and displaying the existing animals of the same type.

External Configuration and Internal Structure of Eozoon.—Owing to the indefinite mode of growth of this gigantic Foraminifer, and the manner in which its fossilized masses are connected with the matrix in which they are imbedded, it is impossible to say with certainty either what was its characteristic *shape*, or what were the limits to the *size* of its individual growths. There is no doubt, however, that these often spread over the area of a square foot, or even more, and attained a thickness of several inches; thus forming blocks which bear a general resemblance to those of the massive Stony Corals, such as *Meandrina*. The aggregation of such blocks, whose continuous extension at their margins would bring them into contact, so that those which originally began from distinct centres would become grafted, as it were, together, seems to have formed Foraminiferal reefs, similar in their general characters to coral reefs; save that while the coral reefs of subsequent epochs, like those of the present time, usually had shells, echinoderms, etc., associated with them (as we know from their remains), in these most ancient reefs the only organic remains yet found are those of the animals which built them. In some of these reefs, from the description given by Sir William Logan, the older portions appear to have undergone fossilization before the newer were built-up on the base which they furnished. Thus, in the Grenville limestone, the lower stratum is composed of large and small masses of white crystalline Pyroxene, some of them twenty yards in length by four or five wide; these appear to be confusedly placed one above another, with many ragged interstices, and many smooth-worn, rounded, large and small pits. In these masses of pyroxene, compact as they appear, are a multitude of

small spaces filled with carbonate of lime; and these show the characteristic structure of the fossil. The spaces between them, moreover, are filled with a mixture of serpentine and carbonate of lime. The whole thickness formed by the aggregation of these masses is not less than two hundred feet; and over their surface is spread a sheet of dark-green serpentine, varying from one-sixteenth of an inch to six inches in thickness. This forms the base of a set of newer growths, composed of alternating plates of carbonate of lime and serpentine; the upper surface of which, again, appears to have been worn and broken up by currents and eddies, so as to modify whatever may have been the original surface given by the natural growth of the animal. The difference that presents itself between the deeper and the more superficial parts of the reef, in the fossilizing mineral which has filled up the cavities in the shell that were occupied during life by the sarcodic body of the animal, seems to mark a considerable difference in the conditions under which this substitution took place; while the fragmentary character of the older pyroxenic portion, and the wear of its surface into cavities and deep recesses, indicate a long period of suspension, during which disintegrating changes were going on, before that renewed growth took place which is represented by the superposed masses wherein the pyroxene is replaced by serpentine.

A vertical section of a well-preserved mass of *Eozoon* exhibits in its basal portion a more or less regular alternation of calcareous and siliceous lamellæ; the former being distinguished by their whiteness, the latter by their light-green hue. This alternation, however, frequently gives place in the more superficial parts to a mutual interpenetration of these minerals; the green spots of the serpentine being scattered over the surface of the section, instead of being collected in continuous bands, so as to give it a granular instead of a striated aspect. This difference depends on a departure from what may be considered the typical plan of growth, which often occurs (as in other Foraminifera) in the later stages; the minute chambers being no longer arranged in continuous tiers, but being piled together irregularly, or in an *acervuline* manner. The contrast between the two modes of growth is well shown by the siliceous model of the animal body which occupied the chambers, represented in the Coloured Plate; the lower portion being that which shows in vertical section a regular series of lamellæ of serpentine, the spaces between which were occupied by lamellæ of calcareous shell; while in the upper is seen the acervuline arrangement of the segments which gives rise to the scattered disposition of the serpentine granules, the calcareous shell having occupied the irregular spaces between these.

The minute structure of *Eozoon* may be determined by the microscopic examination either of thin transparent sections, or of portions which have been subjected to the action of dilute acid, so as to remove the calcareous shell, leaving only the *internal casts*, or *models*, in silex, of the chambers and other cavities originally occupied by the substance of the animal. Each of these modes of examination, as I have elsewhere shown,* has its peculiar advantages; and the combination of both, here permitted by the peculiar manner in which the *Eozoon* has been fossilized, enables us to attain a completeness of knowledge of its structure, such as is afforded by no other fossil with which I am acquainted. For in well-preserved specimens, the shelly substance often retains its characters so distinctly, that the details of its structure can be even more satisfactorily made out, than can those of most of the comparatively modern *Nummulites*. This arises from the fact, that whilst the latter, when imbedded (as they usually are) in a matrix of the same material, have been subjected to *calcareous* infiltration, which has filled-up alike their minute tubules and their larger canals, and has thus rendered the shell-substance nearly homogeneous, these tubules and canals have been filled up in *Eozoon* by a *siliceous* infiltration, which does not coalesce with the substance of the shell, so that the boundaries of the tubules and canals can be distinctly defined. But what renders the condition of *Eozoon* so peculiarly favourable for the investigation of its organic structure, is the marvellous completeness with which the minutest extensions of the sarcode-body of the animal are represented in decalcified specimens by their siliceous models; even the most delicate pseudopodial threads, consisting of the softest and most transitory form of living substance, which were put forth through pores in the shell-wall of less than $\frac{1}{10,000}$th of an inch in diameter, being thus, as it were, perpetuated to all time; and the varieties of their course being exhibited, by what appear under the microscope as most perfect models, in asbestiform fibre, having this advantage over the most skilfully executed works of human hands, that they are not *imitations*, but *the very threads themselves* turned into stone by Nature's cunning. For there can, I think, be no doubt that the siliceous mineral found its way into the cavities of the shell, not by mere *mechanical infiltration* occasioned by pressure from without, but by a process of *chemical substitution* which took place, particle by particle, between the sarcode-body of the animal and certain constituents of the ocean-waters, *before* the destruction of the former by ordinary decomposition.

* Memoir on *Polystomella*, in the *Philosophical Transactions* for 1860, pp. 538, 540; and *Introduction to the Study of the Foraminifera*, pp. 9, 10.

Interpreting the copious information which we derive from these two sources, by the knowledge we already possess of the life-history of existing Foraminifera, we find ourselves able to *reconstruct* our *Eozoon* with at least as much certainty as the comparative anatomist can restore an Iguanodon or a Plesiosaurus. And as the greater part of the details on which this reconstruction rests have been already recorded in the form and order in which they have actually presented themselves to Dr. Dawson and myself,* I prefer that the present description, and its accompanying figures, should place the creature before my readers as it existed in life, whilst building up in the ancient sea-beds those massive reefs which formed the materials of the Laurentian limestones.

The calcareous skeleton or shell of *Eozoon* might be likened to a building made up of successive tiers of chambers (Uncoloured Plate, Fig. 1); the chambers A^1, A^1, A^1, and A^2, A^2, of each tier, however, communicating very freely with each other, so that the segments of the sarcodic layer which occupied them were intimately connected, as is shown by the continuity of their siliceous models (Coloured Plate). In most existing Foraminifera, the successive chambers communicate only by narrow orifices, so that the segments of the body which occupies them are mutually connected by slender bands or *stolons:* but in *Carpenteria* we have an example of a communication nearly as free as that which exists between the chambers of the same tier in *Eozoon;* and I have occasionally met with chambers as completely isolated from the rest as are those of Foraminifera generally, the communication being established by several narrow passages (Uncoloured Plate, Fig. 1, *b*, *b*), exactly corresponding to those which I have described in *Cycloclypeus*. Moreover, I not unfrequently find, projecting from the surfaces of the principal layers, little groups of comparatively small segments, which have budded-forth from the larger ones, and which might almost be taken for internal casts of *Globigerinæ* or other small separate Foraminifera.

The proper walls of the chambers are everywhere formed of a pellucid, vitreous shell-substance, minutely perforated with tubuli, so as exactly to correspond with those of *Nummulites*, *Operculinæ*, etc. These tubuli, as in the existing representatives of the Nummuline series, usually run parallel to each other, passing directly from the inner to the outer surface of the chamber-wall (Uncoloured Plate, Fig. 1, B, B), without coalescence or ramification; and the siliceous casts of the cavities of these tubules often remain *in situ* after the removal

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Interpreting the copious information which we derive from these two sources, by the knowledge we already possess of the life-history of existing Foraminifera, we find ourselves able to *reconstruct* our *Eozoon* with at least as much certainty as the comparative anatomist can restore an Iguanodon or a Plesiosaurus. And as the greater part of the details on which this reconstruction rests have been already recorded in the form and order in which they have actually presented themselves to Dr. Dawson and myself,* I prefer that the present description, and its accompanying figures, should place the creature before my readers as it existed in life, whilst building up in the ancient sea-beds those massive reefs which formed the materials of the Laurentian limestones.

The calcareous skeleton or shell of *Eozoon* might be likened to a building made up of successive tiers of chambers (Uncoloured Plate, Fig. 1); the chambers A^1, A^1, A^1, and A^2, A^2, of each tier, however, communicating very freely with each other, so that the segments of the sarcodic layer which occupied them were intimately connected, as is shown by the continuity of their siliceous models (Coloured Plate). In most existing Foraminifera, the successive chambers communicate only by narrow orifices, so that the segments of the body which occupies them are mutually connected by slender bands or *stolons:* but in *Carpenteria* we have an example of a communication nearly as free as that which exists between the chambers of the same tier in *Eozoon;* and I have occasionally met with chambers as completely isolated from the rest as are those of Foraminifera generally, the communication being established by several narrow passages (Uncoloured Plate, Fig. 1, *b*, *b*), exactly corresponding to those which I have described in *Cycloclypeus*. Moreover, I not unfrequently find, projecting from the surfaces of the principal layers, little groups of comparatively small segments, which have budded-forth from the larger ones, and which might almost be taken for internal casts of *Globigerinæ* or other small separate Foraminifera.

The proper walls of the chambers are everywhere formed of a pellucid, vitreous shell-substance, minutely perforated with tubuli, so as exactly to correspond with those of *Nummulites*, *Operculinæ*, etc. These tubuli, as in the existing representatives of the Nummuline series, usually run parallel to each other, passing directly from the inner to the outer surface of the chamber-wall (Uncoloured Plate, Fig. 1, B, B), without coalescence or ramification; and the siliceous casts of the cavities of these tubules often remain *in situ* after the removal

* See the *Quarterly Journal of the Geological Society*, February, 1865, pp. 51—66.

of the calcareous shell, standing side by side, like the filaments that form the "pile" of velvet, their lower ends resting on the subjacent segment, whilst their upper form a uniform surface so close in texture as to be with difficulty resolvable into the points of its constituent aciculi (Uncoloured Plate, Fig. 2, *a*). This residuary layer (when not thrown off, as it often is, by the disengagement of gas in the process of decalcification) is at once distinguished by its whiteness; as is shown at the upper part of the Coloured Plate on the *surface* of the segments, and at the lower in the *section* of the lamellæ. If a small portion of it be detached with the point of a needle, it is easily shown to be composed of the most delicate asbestiform fibres, each of them representing the original pseudopodium of sarcode which passed through the tubule. But, as I have shown to be often the case in *Operculina*,* the tubuli may depart from their normal parallelism, separating from each other in some parts, and becoming more closely crowded in others; so that instead of the uniform punctation which the *internal* surface of the chamber-wall exhibits, we may find great diversities in the disposition of their *external* orifices, these being often congregated in bands and clusters, with intervals of non-tubular shell-substance between them. A yet greater variety in their course presents itself in *Eozoon*. For the intervals of non-tubular shell-substance left in some parts of the chamber-wall by the crowding together of the tubules in others, are marked in the decalcified layer of asbestiform fibres by fissures in the "pile" (Fig. 2, *b*), such as would be made in the surface of a piece of velvet by doubling it back so as to separate the free ends of the filaments; whilst the convergence of the intervening fibres often unites them into minute flattened leaf-like tufts. A more marked degree of the same convergence, bringing the greater number of the pseudopodia proceeding from each segment into one bundle (Fig. 2, *c*), is not unfrequently seen in parts in which there has been a great development of the "intermediate skeleton" presently to be described; and a portion of the asbestiform layer in which this arrangement is well exhibited, constitutes, under the Binocular Microscope, one of the most beautiful objects with which I am acquainted, every individual thread glistening brightly under appropriate illumination, and holding its own proper place, while an infinite variety of detail is shown in the arrangement of the brush-like bundles, of which no two are precisely similar. Another variety in the disposition of the tubuli is one to which I have seen no parallel in other Foraminifera. Retaining their separate parallelism, they some-

* Memoir on *Operculina* in the *Philosophical Transactions* for 1859, p. 24, and Plate IV., figs. 2, 4; also, *Introduction to the Study of the Foraminifera*, p. 256.

times pass off very obliquely, or even tangentially, so as to run for considerable distances in the chamber-walls; and their asbestiform casts thus form elongated bundles lying on the surfaces of the segmented layers of serpentine.

Between the proper walls of the successive tiers of chambers, there usually intervene layers of very variable thickness (Uncoloured Plate, Fig. 1, c, c), composed of homogeneous shell-substance; these represent the "intermediate" or "supplemental" skeleton, which I have described in several of the larger Foraminifera, and which attains a peculiar development in *Calcarina*.* This is an exogenous deposit on the surface of the proper wall of the chamber, which seems to be formed by the sarcodic layer that originates in the coalescence of the pseudopodia after they have issued from its tubuli, and which is traversed by a more or less minutely distributed "canal-system," occupied during life by prolongations of that sarcodic layer. This canal-system is often brought into view in thin transparent sections of the shell (Uncoloured Plate, Fig. 1, e, e); but as the plane of section will seldom coincide with any considerable part of the course of the passages, a much better idea of their distribution is gained from the study of decalcified-specimens, which present us with siliceous models of the sarcodic extensions that occupied those passages in the living animal. These extensions certainly originate in some cases in the sarcodic segments occupying the cavities of the chambers; in other instances I find them to proceed from the stems formed by the convergence of the brush-like tufts of pseudopodia; but more commonly they seem to have sprung (as I have shown to be probably the case in the recent *Calcarina*) from the sarcodic layer, which is formed by the coalescence of the pseudopodia on the outer surface of the proper wall of the chamber, this layer being represented in the decalcified specimens by a thin plate of serpentine that is often found resting on the extremities of the asbestiform bundles. They differ very remarkably in size and form: being sometimes slender cylindrical rods, which come off from the subjacent layer at regular intervals, and pass straight onwards into the shell-substance without either sub-division or junction; sometimes presenting themselves as broad flattened plates, which gradually thin out to a sharp edge; but being commonly more or less arborescent, and often presenting either beautiful dendritic ramifications (lower part of Coloured Plate, and Uncoloured Plate, Fig. 3) or a sheaf-like divergence of their component filaments. All these representatives of the sarcodic prolongations that occupied the canal-system are distinguished

* Memoir on *Calcarina*, in the *Philosophical Transactions*, 1860, p. 553; and *Introduction to the Study of the Foraminifera*, p. 220.

in decalcified specimens—like the acicular layers occupying the place of the proper walls of the chambers,—by their pure whiteness, which contrasts strongly with the green of the serpentine that has filled the cavities of the chambers; and though this might seem to indicate a difference in the infiltrating material, no such difference really exists. I am informed by Sir William Logan that Mr. Sterry Hunt has determined the chemical identity of the two substances; and hence it is obvious that the whiteness of the internal casts of the tubes and canals is due (like that of pounded glass) to the reflection of light occasioned by the fine division of their component particles; each rod, plate, stem, or branch, being composed of minute asbestiform filaments, which represent, it would seem, so many original threads of sarcode that partially coalesced to form a bundle. Besides these definite shapes, however, we meet in many decalcified specimens with large white amorphous masses of like composition, occupying spaces which must have been originally surrounded by the shell-substance of the intermediate skeleton. The nature of these was for some time a puzzle to me; but I fortunately succeeded in gaining a clue to their character by the decalcification of very thin sections which had traversed them; and I find that they consist in some instances of parallel lamellæ disposed like the leaves of a book, and in others of solid bunches of rounded filaments reminding one of a sailor's "swab;" thus being in each case but a mere aggregation of the elementary forms of sarcodic prolongation already described.

In those portions of the organism in which the chambers, instead of being regularly arranged in floors, are piled together in an "acervuline" manner, there is little trace either of "intermediate skeleton," or of "canal-system"; but the characteristic structure of their proper walls is still unmistakably exhibited, not only in transparent sections, but also in decalcified specimens, wherever the asbestiform layer has not been detached by the disengagement of gas from the surface of the segment on which it should rest.

The mode in which, in the regularly stratified portions of the organism, each successive layer originated from the one that preceded it, does not seem to have been always the same. There is certainly no regular system of apertures for the passage of *stolons*, giving origin to new segments, such as are found in all ordinary many-chambered Foraminifera, whether their type of growth be rectilineal, spiral, or cyclical; and although, when one layer is separated from another by nothing else than the proper walls of the chambers, the coalescence of the pseudopodia emerging from the upper surface of the last formed layer would suffice to lay the foundation of a new layer

of sarcodic segments, it is obvious that where this surface has been overgrown by a thick exogenous deposit of non-tubular shell-substance, some more special provision must exist for the origination of a new tier of chambers above this. Such a provision seems to have been occasionally made by the extension of riband-like prolongations of sarcode, through large passages left in the intermediate skeleton, proceeding from the chambers beneath, and opening on its upper surface; for I have not only occasionally met with such flattened passages in transparent sections of the shell (Uncoloured Plate, Fig. 1, D), but have still more frequently found the void spaces in decalcified specimens, left by the removal of the thickest layers of the intermediate skeleton, to be traversed by the internal casts of such passages, which seem to represent the sarcodic stolons of the living animal body.*

The origination of new layers, however, seems more frequently to have taken place in a much larger extension of the sarcode-body of the pre-formed layer; which either folded back its margin over the surface already consolidated (in a manner somewhat like that in which the mantle of a *Cypræa* doubles back to deposit the final surface-layer of its shell), or sent upwards wall-like plates, sometimes of very limited extent, but not unfrequently of considerable horizontal length, which, after traversing the substance of the shell, spread themselves out over its free surface. For it is frequently to be observed in decalcified specimens, that two bands of serpentine (or other infiltrating mineral), which represent two layers of the original sarcode-body of the animal, approximate each other in some part of their course, and come into complete continuity (as on the left-hand side of the Coloured Plate), so that the upper layer would here seem to have originated in a folding-over of the lower. And even where these bands are most widely separated, we find that they are commonly held together by vertical dykes of the same material, which traverse the intervening calcareous layers like trap-dykes passing through a bed of sandstone. That such have not been formed by mineral infiltration into accidental fissures in the shell, but represent extensions of the sarcode-body of the living animal, is indicated not merely by their distinct continuity with the horizontal layers, but also by the fact that portions of the canal-system may frequently be traced into connexion with them.

The only information which seems to me yet wanting to bring up our knowledge of the life-history of this organism to the highest level of that (still far from complete, especially as

* See the white bands passing from the middle of the lowest layer in the Coloured Plate to the layer next above it.

regards the generative process,) which we possess in respect to the best-known existing representatives of the Foraminiferal group, is that which concerns the early stage of its development. At present we know *Eozoon* only in its massive forms; and we have no clue, save that furnished by analogy, to the mode in which these are built up. In the *Rotaline* series, which is characterized by the *coarse* perforation of the shell, we find the original spire of *Planorbulina* overgrown by chambers piled upon it in an irregular acervuline manner; in *Tinoporus*, whose young state closely resembles the early form of Planorbulina, the chambers, successively superposed on the original spire and its marginal extension, are piled in layers of greater regularity; while in *Polytrema* similar rotaline chambers bud forth one from another, in such a manner as to give to the organism the aspect of a minute branching Coral, for which it was long mistaken. Now, in virtue of the *fine* tubulation of the proper walls of its chambers, *Eozoon* belongs to the *Nummuline* series, of which I have shown this structure to be the special characteristic; and this series presents a remarkable parallelism, as regards variations in mode of growth, to the Rotaline. For we may pass from the typical *Operculina* or *Nummulina*, through *Heterostegina* and *Cycloclypeus*, to *Orbitoides*, in which, as in *Tinoporus*, the chambers multiply both by horizontal and by vertical gemmation; and between this and *Eozoon* the difference is not greater as regards plan of growth than between *Tinoporus* and *Polytrema*.*

Notwithstanding the striking contrast which is presented between the massive growths of *Eozoon* and those microscopic *Rotaliæ*, *Miliolæ*, etc., which are the examples of the Foraminiferal type most familiar to collectors on our own shores, there is no more essential difference in plan of structure, than that which exists between the most insignificant flowering plant and the gigantic Wellingtonia or the wide-spreading Banyan. In the one case, as in the other, the difference consists, not so much in the size of the individual parts, as in the extent to which these parts are multiplied by the production of new buds in continuity with the pre-existing fabric. A contrast scarcely less remarkable exists among the Foraminifera of the existing epoch. Thus the shells of the minute *Globigerinæ*, which cover to an unknown thickness the sea-bottom of all that portion of the Atlantic Ocean which is traversed by the Gulf stream (the "ooze," of which specimens are brought up by the sounding apparatus, containing not less than 95 per cent. of them), consist of not more than eight or ten chambers, showing that the *continuous* increase of the individual body by

* See the descriptions of the Structure of these Generic types in my *Introduction to the Study of the Foraminifera.*

the gemmation of new segments ceased at that point; and that if new segments be still budded-off, they detach themselves, so as to lay the foundation of new *Globigerinæ*. On the other hand, in the large discoidal *Cycloclypeus* of the coast of Borneo, which attains a diameter of $2\frac{1}{4}$ inches, the number of segments formed by continuous gemmation must be many thousand.

It is a fact of no little interest, that we have another example of the comparatively gigantic development of the Foraminiferal type in what would have been formerly accounted the earliest fossiliferous rocks. Some years since, Mr. Salter, then the Palæontologist to the Geological Survey of Great Britain, showed me some fossil remains which he had received from the Silurians of Canada, and asked my opinion respecting them. My reply, after a not very detailed examination of them, was to this effect:—"If it were not for their gigantic size, I should say that they were internal casts of an Orbitolite." Having subsequently received additional specimens of these fossils, and having carefully compared them with my description of the genus *Orbitolites* in the *Philosophical Transactions* for 1855, Mr. Salter felt himself justified in identifying them with that type; and published an account of them (under the designation *Receptaculites*) with excellent illustrative figures, in the *First Decade of Canadian Organic Remains*. Now the largest recent *Orbitolite* I have seen is about the size and thickness of a shilling; whilst the Canadian *Receptaculites* attains a diameter of twelve inches and a thickness of a third of an inch; and if this had increased by vertical as well as by horizontal gemmation, piling up its chambers in successive tiers like the recent *Tinoporus* or the fossil *Orbitoides*, it would have formed a mass equalling *Eozoon* in its ordinary dimensions.

Remains of *Eozoon* are not by any means confined to Canada. The serpentine marble of Tyree, which forms part of the Laurentian system on the West of Scotland, and a similar rock in Skye, when subjected to minute examination, are found to present a structure clearly identical with that of the Canadian *Eozoon*. And the like structure has been discovered by Mr. Sanford in the serpentine marble of Connemara, well known to ornamental builders under the name of "Irish green." I have examined several pieces of this rock by placing them in dilute acid, and have not the smallest hesitation in identifying the residuum with the *acervuline* portion of the corresponding residuum of the Canadian *Eozoon*, shown in the upper part of the Uncoloured Plate: I have not, however, met with anything corresponding to the lamellated structure shown in the lower part of that plate. Moreover, I find, in place of a

continuous asbestiform layer covering the segments, long straight bundles of asbestiform filaments radiating from them. What is the import of these—whether they represent a part of the original structure of the animal, or are (as I am disposed to suspect) a product of subsequent metamorphism—is a point which must be reserved for further investigation. The age of the Connemara rock, too, can scarcely be regarded as conclusively settled. Sir Roderick Murchison, by whom its relations were carefully studied some years ago, seemed not indisposed, when it was first found to contain *Eozoon*, to believe that it might belong to the Laurentian series; but he has since withdrawn that admission, and has expressed the opinion that the Connemara marble is of Silurian age.* If this be the case, it proves that *Eozoon* was not confined to the Laurentian period, but that it had a vast range in time, as well as in geographical distribution; in this respect corresponding to many later forms of Foraminifera, which have been shown by Messrs. Parker and Rupert Jones to range from the Triassic to the present epoch.

It is much to be desired that a careful examination should be made of all Serpentine marbles that contain a Calcareous admixture. Such admixture may be at once detected by their effervescence when touched with dilute acid; and if, on the removal of the lime by continuous maceration in acid, the siliceous residuum should exhibit forms bearing any decided resemblance to either portion of the Uncoloured Plate, the participation of *Eozoon* in their original production may be confidently inferred. It is specially to be desired that search should be made for it in any limestone beds occurring in the Laurentian rocks of Scandinavia, and in those of Bohemia and Bavaria.

It is not only, however, in those rocks which exhibit well-preserved representations of the original animal, that we may trace the agency of *Eozoon* in extracting from the ocean-waters the materials now forming the solid crust of the globe. There can be no reasonable doubt that—as has occurred in many subsequent epochs, and may be shown to be in progress at the present time—there was a continual disintegration, by the mechanical force of the ocean-waters, of those structures which had been built-up by living agency; and that the particles resulting from the progressive wearing-down of the Foraminiferal reefs would be deposited as sediments elsewhere, and, when subjected to subsequent metamorphic action (as by the infiltration of heated water) would be converted into highly crystalline limestones. Sir William Logan has shown me thin sections of solid masses, which presented unmistakable

* See the *Geological Magazine* for April, 1865.

evidence, when microscopically examined, of having been made up of an aggregation of fragments of the proper walls of the chambers of *Eozoon;* these fragments presenting the most beautifully preserved examples I have yet seen in transparent section, of the characteristic Nummuline tubulation. And as these sections presented no indication of such remains of a canal-system as would have marked the presence of fragments of the intermediate skeleton, I am disposed to think that the breaking-up of the surface of the original *Eozoon* must have taken place before the proper walls of its highest tiers of chambers had been strengthened by exogenous deposit. Further, in sections of Laurentian limestones, which did not exhibit to the naked eye any evidence of organic structure, Dr. Dawson was able, by microscopic examination, to recognize minute fragments, of whose derivation from *Eozoon* there could be no reasonable doubt.

Hence, it would appear that these gigantic Rhizopods performed, in the seas of the Laurentian epoch, the same part in the production of limestone rocks which was subsequently taken by Coral polypes, Echinoderms, and Mollusks, as well as by minuter forms of Foraminifera. And it is a fact not without an important significance, that this, the lowest type of animal life known to the Physiologist, should have thus culminated in the very earliest period in the history of the life of our globe with which the Palæontologist is at present acquainted. If, as I consider, that we are quite justified in doing, we refer the animal of *Eozoon* to the type whose characteristic features we are able to study in our existing *Rotaliæ* and *Miliolæ*, we may say of it, as I have elsewhere stated of the Foraminifera generally,* that its substance "does not present any such differentiation as is necessary to constitute what is commonly understood as 'organization,' even of the lowest degree and simplest kind; so that the physiologist has here a case in which those vital operations which he is accustomed to see carried on by an elaborate apparatus, are performed without any special instruments whatever—a little particle of apparently homogeneous jelly changing itself into a greater variety of forms than the fabled Proteus, laying hold of its food without members, swallowing it without a mouth, digesting it without a stomach, appropriating its nutritious material without absorbent vessels or a circulating system, moving its parts without muscles, feeling (if it has any power to do so) without nerves, propagating itself without a genital apparatus, and forming a shelly covering that possesses a symmetry and complexity not surpassed by those of any testaceous animals." It is not possible to conceive any living being of greater simplicity

* *Introduction to the Study of the Foraminifera*, Preface, p. vii.

than a Rhizopod of the Foraminiferal type; its homogeneous jelly-like substance not being even invested by the semblance of a membrane, so that its pseudopodial extensions, when they meet each other, coalesce like the glutinous threads separately proceeding from the spinnerets of a Spider. But it *is* possible to conceive of a system of rocks preceding the Laurentian, as the Laurentian preceded the Cambrian, and the Cambrian preceded the Silurian; and it would be a most rash assumption to maintain that the first appearance of *Eozoon* above the Laurentian horizon really marked the dawn of animal life on our planet. As Dr. Dawson has justly remarked, "though the abundance and wide distribution of *Eozoon*, and the important part it seems to have acted in the accumulation of limestone, indicate that it was one of the most prevalent forms of animal existence in the seas of the Laurentian period, they do not imply the non-existence of other beings. On the contrary, independently of the indications afforded by the limestones themselves, it is evident that in order to the existence and growth of these large rhizopods, the water must have swarmed with more minute animal and vegetable organisms on which they could subsist."

It would be difficult, I think, to find a more "pregnant instance" of the value of Microscopical investigation than that which is afforded by the discovery of which I have now given an account; a discovery which I am strongly disposed to regard as only the first of many similar results, which will follow its intelligent application to the study of the internal structure of other fossils, hitherto known only by their external forms. The organic structure and precise zoological affinities of a body which was at first supposed to be a product of purely physical operations, have been shown to be determinable with certainty from the examination of a particle which a pin's head would cover; and we are thus enabled to predicate the nature of the living action by which it was produced, at a Geological epoch whose remoteness in *time* carries us even beyond the range of the imagination, with no less certainty than the Astronomer can now, by the aid of spectrum-analysis, determine the chemical and physical constitution of bodies whose remoteness in *space* alike transcends our power to conceive.

EXPLANATION OF PLATES.

The *Coloured Plate* represents the various appearances exhibited by a specimen of *Eozoon Canadense*, which has been macerated in dilute acid, so as to dissolve away the calcareous shell which originally contained the body of the animal, now replaced by its model in green serpentine. In the lower part of the plate the segments are seen to be united into continuous

horizontal lamellæ, which are connected with each other at intervals by vertical bands; in the upper part, the segments preserve their distinctness to a much greater degree, and are piled one upon another without any regular plan. The exposed surface of the segments, both in the lamellated and in the acervuline portions, is seen to be whitened by the asbestiform layer, also shown as a narrow edging in the sectional view of the lamellated portion. This layer consists of the needle-like siliceous filaments which take the place of the pseudopodia originally, occupying the minute parallel tubuli of the proper walls of the chambers, and which remain *in situ* after the removal of the calcareous shell that was traversed by them. Between the two lower lamellæ of serpentine, in the broad space originally occupied by a thick layer of the "intermediate skeleton," is seen on the right the siliceous model of a small group of stolon-processes, which passed directly from the sarcode body occupying the chambers of the lower tier to that of the tier next above, whilst on the left is shown the internal cast of a part of the canal system, forming a model in serpentine of the arborescent clusters of sarcodic prolongations which occupied it.

Tinted Plate.—Structure of Eozoon.—Fig. 1. Portion of the calcareous shell (restored), the contents of the chambers having been removed. A^1, A^1, A^1, chambers of a lower tier, communicating with each other freely at *a*, *a*, and separated from an adjacent chamber at *b*, *b*, by an intervening septum traversed by passages. A^2, A^2, chambers of an upper tier. B, B, B, B, proper walls of the chambers, traversed, as in the *nummuline* type, by fine tubules. These tubules are seen, in the upper wall of the chambers, A^2, A^2, to pass with uniform parallelism, from the inner to the outer surface, where they open at regular distances from each other; but in the upper wall of the chambers, A^1, A^1, A^1, the tubules are seen to converge in their passage outward, so as to open on the surface in irregular bands and clusters. C, C, C, intermediate skeleton, composed of homogenous shell substance, traversed at D by a stoloniferous passage connecting the chambers of two tiers, and at E, E, E by the canal system.

Fig. 2. Highly magnified portion of the asbestiform layer, left after the decalcification of the shell-wall, showing varieties in the arrangement of the siliceous internal casts of the tubules, which represent the pseudopodia that occupied them in life. At *a* is shown the uniform surface given by the ends of the closely-packed parallel *aciculi*, which are seen standing side by side in the sectional view beneath. At *b*, the uniformity of surface is interrupted by the partial convergence of the aciculi, leaving vacant spaces between. And at *c* is shown the more

complete convergence of the siliceous threads into brush-like bundles.

Fig. 3. Internal cast of a portion of the canal system, in a decalcified specimen, showing the arborescent distribution of the sarcodic prolongations which occupied it during life.

TEN YEARS IN SWEDEN.*

THERE is a manifest tendency towards an increase of communication and connection between England and Sweden. Its vast stores of the richest and purest varieties of iron ore, and the ample supplies of serviceable timber abounding in its extensive forests, attract the notice of the speculative capitalist, who sees in them important sources of wealth hitherto imperfectly developed, and offering splendid prospects of profit to enterprises carried out on a sufficient scale, and with adequate skill. The naturalist and the sportsman find their attention turned to Sweden from the interesting character and variety of its wild animals; while the manners of the people, their Protestant faith, and free political system, tend to render their country an agreeable residence for English families during the milder portions of the year.

It is easy to understand why, notwithstanding the merits of the people, Sweden has been somewhat slow in making the most of her resources. Though a large country—nearly three times the size of England and Wales—only a small part is fairly adapted to agriculture, and much of the wealth in minerals and timber can only become accessible through the construction of railways, the improvement of river navigation, and other proceedings of a costly kind. Out of 3868 Swedish square miles, which Agardth estimates as the total area, lakes occupy one-eighth, or 498 Swedish square miles, fells and barren plains take up 1500, forests 1623, leaving only 247 for meadow and arable land. By degrees the cultivated portion will, no doubt, be considerably increased, but the climate opposes serious obstacles, and it is from her mines and her forests that Sweden must expect to obtain the means of purchasing food and comforts for her growing population.

A really good book upon this interesting and important country has been much wanted, and such a work could only be written by a shrewd observer, who had domesticated himself amongst the people, and become familiar, through a lengthened residence, with their language, customs, habits, and resources. Such a work the "Old Bushman" has produced, and we feel no hesitation in saying that, for some years to come, his *Ten Years in Sweden* will be an acknowledged authority, to which merchants, capitalists, naturalists,

* *Ten Years in Sweden;* being a Description of the Landscape, Climate, Domestic Life, Forests, Mines, Agriculture, Field Sports, and Fauna of Scandinavia. By "An Old Bushman," author of "Bush Wanderings in Australia," "A Spring and Summer in Lapland," etc. Groombridge.

sportsmen, and tourists will refer, and find stores of well-digested information, which bears evident marks of having been conscientiously collated and honestly given forth.

The season for visiting Sweden has now come. During the winter, with its short days and long dark nights, few travellers would wish themselves in a country not adapted to outdoor amusements, and which can only be tolerable to those who have opportunities of enjoying the hospitalities of its domestic life. In the northern parts the allowance of daylight becomes microscopic, and in the middle the "Old Bushman" describes the winter as dull and monotonous, "eighteen hours dark to six hours daylight, and it is often impossible to get into the forest for weeks, on account of the snow; and if you can, there is scarcely anything to shoot." If the weather is propitious, "the sledging is first-rate," and country houses are scenes of social gathering and festivity. In May a sudden change comes on. "A few dull, misty days, with warm wind and rain, and the whole face of the country changes, as if by magic. The green rye appears as the snow rapidly melts away," the wood anemone puts forth its blossoms, and trees suddenly burst into leaf. "Now all again is activity and bustle out of doors; animal as well as vegetable life, all at once wake up from their winter slumber, and for six months the farmer, sportsman, and naturalist have not a day to spare."

It must not, however, be supposed that the winter is an idle time for the natives. As soon as the ground becomes frozen in the autumn, the men of a forest district are off to their work. Their first proceeding is to dig a hole in the ground about ten feet deep, which has a cover built over, leaving a smoke-hole. This is the forester's hut, in which he lives, dining on herrings, cheese, and meal, which he brings with him. On Sundays he goes home, and on other days he fells the trees, and when the snow is hardened, and the ice on the lakes will bear weight, the timber is dragged along to the nearest stream capable of floating it down when the warm weather returns. The management of the forests is described as very wasteful, and in cutting the trees the woodman uses an axe, stands upright as he works, and strikes about four feet from the ground, so that much valuable timber is lost. The birch thrives well with the fir. It makes its appearance when the fir woods are cut down, and in young plantations it is valuable on account of its faster growth. At the age of ten it is hard enough for firewood, and at fifty it attains full growth. "As the birch trees are cut down, the more valuable trees are left. The birch thus pays for planting and pruning the better trees, which fatten the land, while the birch when planted alone impoverishes it." The pine takes a longer time to reach maturity, varying, according to the district, from 180 to 300 years. The "Old Bushman" supplies some curious facts and estimates concerning the age and dimensions of these trees. Thus, up the Tornea River—N. lat. 66° 40′—a pine with a diameter of 7½ inches is reckoned to be about 100 years old; 11 inches, 150; and 13¾, 200. "So, according to these proportions, it appears that in this latitude a pine grows one inch in diameter in every ten years during the first

century, but in the second century, only one inch in every twenty-two years." At Gefle, which is a few degrees more south (60° 4′ N. lat.), the growth of pine is much quicker, reaching 14 inches diameter in about 100 years, 18¼ inches in 150 years, and 23½ inches in 200 years. In the middle of Sweden—N. lat. 59° 20′—a pine tree of 20 inches diameter at the root can be grown in 100 years, and it will be 100 feet high. At 20 feet from the ground, such a tree will have a diameter of 15 or 16 inches; thus, we see how much a little extra warmth and light will do for the promotion of timber growth.

In the proposals which are made to English capitalists to embark in Swedish enterprises, forest managing and timber cutting play an important part; and in many cases great mining enterprises are naturally and necessarily associated with these questions. On the whole we entertain a favourable opinion of the capacities of Sweden as a locality for investment, but to judge wisely of any particular project a great deal of information is required of a class that is usually suppressed in flourishing prospectuses; and we should strongly advise no one to invest a sixpence in such undertakings, without duly considering the various facts which the "Old Bushman" has so industriously collected. We do not doubt, for example, that the famous Gellivare district is one mass of possible wealth, but without offering any opinion on the projects of those who have undertaken to work it, a prudent speculator would require to know a great deal about the peculiarities of the climate, and the probable chances of inducing a sufficient population to settle in a district, that without the application of much skill and capital can only offer a partial subsistence to a miserable few. In considering these and many other important points, the work before us offers invaluable aid; and without intending a left-handed compliment to its author, we may say that his evidence is all the more trustworthy, because he has collected his information without having any speculative object in view. The climate and soil of Sweden forbid the gradual development that many other countries experience. Many large districts must remain uninhabited and worthless until a great change can be rapidly impressed upon them by associated enterprise; and provided judgment be exercised, a very great outlay upon a comprehensive scheme would offer reasonable chances of remuneration, while smaller though considerable disbursement on less complete plans would be sure to fail.

Seven-eights of the Swedish people live in the country, and it has no cities that would be called large in comparison with our own; Stockholm having only 116,496 inhabitants, according to the census of 1861. Next comes Gothenburg, with 38,504 inhabitants; Norrköpping, with 20,228; Malmö with about as many, and no other exceeding 10,000. Greater possibilities of living by agriculture have caused the southern provinces to be ten times more populous than the northern ones, which can never support any considerable number except the mining and timber industries can be made to furnish enough money to purchase necessaries and conveniences that cannot be produced on the spot. "The timber crop," says our author, "is the true harvest of the north;" and to make the most

of it means of communication must be created that have no existence at present, and which could only pay by being carefully adapted to the requirements of mining districts. Swedish agriculture is stated to be improving, through the good practical education afforded in the farm schools established by the government; but dairy produce appears neglected, notwithstanding its ready sale.

The "Old Bushman" considers the present working of loan societies as unfortunate for agriculture. He complains that men not properly brought up to the business buy land with money borrowed from these institutions, and have not sufficient capital to work it. Such a state of things will probably cure itself, as there can be no inducement for men to engage in enterprises that fail to be remunerative. The failure of injudicious speculations of this kind, and the practical knowledge diffused by the farm schools, will cure the delusion that agriculture is a process in which ignorance and insufficient capital can succeed.

Rye is the principal grain crop in Sweden, and "most of the day-labourers are what they call *torpare*," that is, servants at will on the estate, who farm a bit of land, estimated at a high rental, and who work when required by their landlord, at a fixed sum per day. These men and their families are under what we should call a "truck system," being obliged to buy what they require at the landlord's shop, and until the country has made considerable progress, it is not likely that this class of trade will fall into independent hands, and be governed by the usual operation of commercial laws. A good labourer earns one shilling a day in Wermland, and female farm servants only receive £2 annual wages and their keep. For this delightful pittance these poor women are kept at constant work. "They never appear to know rest," and "if there is an hour to spare, there is always a spinning-jenny to sit down to." Part of their occupation is killing the calves and sheep!

The Swedish peasant has sturdy, sterling qualities, but, according to the "Old Bushman," "stingy past all belief," and constantly thinking of rix-dollars, of which, we apprehend, he does not see too many with all his care. A bad kind of brandy, called *branvin*, is one key to his heart, and tobacco another. He is also described as well-behaved and reliable, though not given to do things in a hurry, or change his plans. Altogether he is an estimable person, who deserves to share in the progress which we hope his countrymen are destined to make.

The arrangements for the relief of the poor in Sweden are very peculiar, and are reported to work better than might be supposed. No workhouse or Union receives the pauper class, and the poor rates are levied in grain. "Early in spring an auction is held, to which all aged and helpless paupers are brought, in order to be let for the year; each pauper is put up to a bidding, after the manner of a Dutch auction, to see who will take and keep him, or her, for a year at the lowest price, and a good deal of speculation often goes on among the assembled farmers. A helpless old pauper will be taken for eight tunna* of oats a year, and one with a little work left in him

* A tunna is little less than five bushels.

for less. The person hiring one of these unfortunates has to provide clothes as well as food, and they are usually well treated, as the Swede is naturally a kind master."

The ecclesiastical arrangements of Sweden differ from our own. The parishioners in certain cases choose their clergymen, and the clergy of a district choose their bishop. A curate begins with a stipend of about £10 and his keep, and his first living may be worth about £40 a year, the income being generally derived from a small farm, together with yearly payments of butter, etc., from the parishioners. Bishops are obtained as economically as parish clergymen, and even the Archbishop of Upsala, the Primate of the Swedish church, has an income of only £1200 a year. This moderate pay does not prevent the clergy from being held in high estimation, and they exert a powerful influence over the domestic life of all classes. Education is cheap in Sweden, and while the working men are better taught than our own, the middle-class have two good universities at Lund and Upsala, in which the total expenditure is from £3 to £4 per month.

With regard to the cost of living in Sweden, the "Old Bushman" remarks, that a man with a family, who cannot do without English comforts, can live as cheap at home; but, he adds, a sportsman can do well with £50 a year, if he hires a room and buys his own provisions; enjoying considerable facilities for obtaining various sorts of game. Ample details are given for those who contemplate a visit to the country, and it is evident that much enjoyment may be obtained at a moderate cost. In 1864 mutton was 4*d.* per lb., beef 3*d.*, pork 4*d.*, chickens 9*d.* each, eggs, 7*d.* per dozen in summer, oatmeal, 1*s.* for twenty pounds. The meat, except the mutton, is not praised, and the ordinary bread of the country would scarcely commend itself to English tastes. It is "made of hard rye, in thin cakes as large as a plate. This is hung up, and will keep any length of time. In some large houses they bake only twice a year; but they can also make just as good light wheat bread as in England." The last announcement carries consolation for travellers, as we think most of them—from this country at least—would be loth to interfere with the valuable keeping properties the native article is said to possess.

With many points of resemblance, the Swedes and the English have also marked differences in habit, partly, no doubt, resulting from the peculiarities of the climate in which the two nations live. Swedish boys are not fond of the athletic games that delight our youth, and their young men have no substitutes for the cricketing, boating, etc., that ours judiciously practise. With us winter is a season of physical activity for the well-to-do classes. In Sweden it is the reverse. The country gentleman has no hunting or shooting at that season, he rarely walks a mile, and the houses are made unwholesomely hot by stopping ventilation and heating the stoves.

We have in the preceding remarks afforded our readers a general outline of what a capital book the "Old Bushman" has made, and, as his matter is well arranged and condensed, he has contrived, in

less than six hundred pages, to present a great store of information on a variety of topics, and also to add what the naturalist will consider very valuable—a list of the mammalia, birds, and reptiles of Sweden, with descriptions of genera and species drawn from the best sources, and supplemented by observations which his own experience has supplied. The "Old Bushman" speaks very modestly of this portion of his labours. He says, "It is, in fact, a compilation from beginning to end; but, nevertheless, a compilation prepared with an immense deal of trouble, labour, and close attention. To take Nillson's *Fauna* in hand, and merely give a list of such animals as are met with in Scandinavia would have been a very simple affair, but to refer to the best authorities on the fauna of four large Northern countries, as well as of Great Britain, to compare them with each other, to see how far their observations tallied with my own experience, and then to pick out from all the best and shortest account of the different species, with its easiest and most reliable specific distinctions, was a work of no little labour."

We cannot doubt that naturalists will place a high estimate upon the perseverance and skill with which this portion of the work is carried out, and, in conclusion, we have only to commend the "Old Bushman's" record of his *Ten Years in Sweden* to all who, from whatever motive, or with whatever object, desire to obtain information on which they can rely.

ARCHÆOLOGIA.

The Archæological Institute has recently had under discussion a question of the greatest importance to every one who feels an interest in Archæology—that of TREASURE TROVE. It would not be easy to overstate the quantity of valuable antiquities which have been lost and destroyed through the operation of the law upon this subject as it now stands. According to mediæval principles, whatever was found without any clearly traced legal owner was held to belong to the king. Generally speaking, antiquities found buried in the ground had then very little acknowledged value; but this was not the case with money in times when it was scarce, and had a very high value in comparison with the ordinary articles which were purchased with it, or even with land itself. It has been from very early times the usual method of preserving money to bury it in the ground. A house, generally, was not a safe place, as it was liable to be entered and plundered by the numerous strong bands of robbers who infested every part of the land, town or country, and this was the case down to a recent period. The reader will remember the anxiety of Secretary Pepys, as he tells it in his diary, when, during the great fire of London, he buried his money in his own garden, and still more when, after the fire, he went to dig it up. In the same manner, the Romans, and the Saxons, and the Normans,

and, to a greater or less extent, all those who inhabited the land before Pepys' time, kept what they had of cash, more than enough for ordinary use, not in a strong box in a room in the house, from which it might be carried away, but by burying it either within the house, or in the yard or garden: for it must not be supposed that the hoards of ancient coins which are so frequently found in digging in fields, or roadsides, were merely placed in the earth in the open country. They lay no doubt originally within some building or inclosure, the traces of which have now disappeared. Life was then very uncertain, and the owners of these treasures were often cut off without leaving anybody acquainted with the place where their money was concealed, and it remained undisturbed until accidentally discovered in ages long subsequent. It is but natural for men who possessed landed property to look upon whatever they found in it as belonging rightly to themselves, and hence arose conflicting claims between moral right, or supposed moral right, and legal right, which, in times when people who were strong enough oftener committed it to the decision of force than to law, led to disastrous feuds and even to wars. It was well known how Richard Cœur de Lion met his death. Richard's feudal vassal, the Vicomte of Limoges, having found a treasure on his estates, sent a part of it to the king in the hope of appeasing him; but the latter, having been made acquainted with the circumstances of the case, claimed the whole, and, on the vicomte's refusal to surrender it, assembled some troops, marched against him, and, in an attack upon his castle, received his death-wound. In other instances, the law of treasure trove was made the instrument of vexatious acts of oppression and injustice. A curious case of this kind occurred in Ireland in the earlier half of the fourteenth century. A married man in the town of Kilkenny, who appears to have united the businesses of banker and usurer, buried his ready money within his house—we may suppose under the floor of his cellar. He was involved in a quarrel with some of his relatives, who had learnt somehow or other the circumstances of the burial of his money, and one day, during his absence from home, they broke into his house, dug up the money, and carried it away. Proceedings were, of course, commenced against them for the robbery, but, when the case appeared clearly to be going against them, they turned round, and pleaded that the money was treasure trove, because found buried in the earth, and that they were ready to give it up to the king, to whom it belonged. This brought an interruption to the original trial, and led to a new course of proceedings, which, in the then slow process of law, although the owner of the money could easily establish his right to it, tormented him for several years before it was decided.

These anecdotes will be sufficient to show the great inconveniences attending the law of treasure trove as a royalty. Like other royalties, such as the right to mines of the precious metals, it remained in the crown after the lands were given away, and could only be alienated by a special grant. The feudal barons, therefore, and especially the church and the ecclesiastical barons, laboured to obtain this special grant with their estates, and gradually the right of

treasure trove became very generally transferred from the crown to the lords of the manors. These seized upon the treasures found upon their estates, whenever they were worth the trouble, and nothing further was said about it, unless the find presented some remarkable characteristic. As lords of manors, even in recent times, rarely possessed any knowledge of archæology, and therefore took no interest in mere antiquities, and as stores of coins of any value for the metal only turned up at rare intervals, they took no care about the matter, and the law of treasure trove was allowed to remain a dead letter, except on particular occasions, when the value of the deposit, or the historical interest of the articles found, called their especial attention to it. The advantage thus derived from the law was merely nominal, while it was extensively injurious to the cause of science. The agricultural or other labourer who found a deposit of ancient coins or other antiquities, ignorant of their real value, yet knowing they were worth something, believed that he had morally a right to what he had found; at the same time, he knew that the lord of the manor had the law on his side and could take them from him, and that, moreover, he was liable to severe punishment for appropriating them. He, accordingly, concealed the discovery, sold the objects, when he could, to dealers, who gave him but a small part of their value, or to curiosity collectors, who gave him more; but, in either case, they were lost to science—the coins of gold or silver often went to the melting-pot, and the other objects were scattered, and in a short time destroyed, and at all events they were deprived of a great part of their historical value by being dissociated from the locality in which they were found. The loss which archæology has sustained from this state of things, since it has been cultivated as a science, is incalculable, and greatly to be lamented.

The subject was brought before the Archæological Institute, in a paper by Mr. Godfrey Faussett, who gave a sketch of the history of the law relating to treasure trove from the earliest period at which we have any information on the subject. The Roman law, he said, varied much in regard to the appropriation of treasure found without an owner. The Emperor Constantine adjudged it to the treasury, but, if it were brought in voluntarily, one-half was restored to the finder. Gratian vested the whole in the finder, but provided that, if the finder were not the owner of the soil, the latter should be entitled to one-quarter. This was acknowledging some right to treasure trove in what we should now call the lord of the manor. Valentinian II. gave the whole to the finder. This was changed again by Justinian, who ordered that treasure thus found should be divided equally between the landholder and the finder, and this appears to have remained afterwards the established Roman law. It was adopted in the Code Napoleon, and is still the practice in some countries. When we do find any regulations relating to treasure trove among the Anglo-Saxons, which is not before the reign of Edward the Confessor, treasure found in the earth was considered to belong entirely to the king, unless found in a church or cemetery, in which case the gold belonged to the king, and half the silver to the church, the other half to the king. Under the

Normans, treasure trove was altogether a royalty. The crime of concealing treasure thus found amounted to death, or loss of limb, which was at a later period commuted for fine or imprisonment. Mr. Faussett described the misapprehensions which had existed in regard to the law on this subject in modern times, and the proposals which had been made for amending it. In 1860, Sir George Cornewall Lewis, then Chancellor of the Exchequer, issued a well-known "circular" to the police, who were directed to claim all coins, gold or silver ornaments, and other relics found in this manner, for the crown, but to pay the finder their full value on his giving them up; and the circular further directed that, in cases of concealment which might come to the knowledge of the police, measures should be taken for the recovery of the treasure. This measure, as antiquaries know, has proved a complete failure, and only increased the difficulty it was intended to remove. Mr. Faussett seems to ascribe this in a great measure to the employment of the police, which he thinks was calculated to raise suspicion and ill-feeling; while, by asserting a claim to all ancient relics, and not to the precious metals only, the question became perplexed, and no intention was expressed as to the destination of the treasure which was to be delivered up. He offered some suggestions for the future arrangement of this question, which, at present, is certainly in a very unsatisfactory state. He is opposed to the opinions of those who wish the sovereign to waive all claim to the treasure trove, and vest the property of such discoveries entirely in the finders, because he thinks that this would be merely equivalent to an attempt to discourage pilfering, by giving the thief what he covets, and he thinks that this would benefit none of the parties concerned. He proposes an amended "circular," to the same effect as that of Sir George Lewis, with this especial difference, that the future destination of objects secured by Government should be distinctly set forth, accompanied with a well-defined statement of what the crown may and will claim, and the offer to purchase such objects as are not claimed, in addition to that of liberal and prompt remuneration for what it does claim; and he especially urges the elimination, as far as possible, of the police element in the transaction. In regard to this latter difficulty, Mr. Faussett suggests that, in some way or other, which we do not very clearly understand, the principal post-offices throughout the kingdom might be used as an agency in place of the police. Mr. Faussett's paper led to a long and rather warm discussion of the question, in which Mr. John Evans and some other speakers advocated the expediency of abandoning all claim on the part of the crown, or lords of manors, over treasure trove, as the best way of ensuring the proper preservation of the objects found. We confess ourselves much inclined to Mr. Evans's opinion. The real difficulty in all such plans as the "circular," or the proposed amended circular, arises from the circumstance that it necessarily implies a transaction between two ignorant people. The finders of antiquities in the country are usually agricultural labourers, who of course know nothing about them, and it will be a long time before the members of the police force or the men employed in country post-offices will have

become competent antiquaries. The only real effect of the law which creates a different claimant from the finder is to enforce concealment, which, of course, implies the loss of a great proportion of the objects found. It is generally a labourer who finds such object, while at work in the fields, or perhaps digging his own garden; he can see no reason why it should not be his own as much as the pebble he picks up and puts in his pocket, but he has an imperfect conviction that it has some value, and that he is liable to be deprived of it. He, therefore, keeps it from the knowledge of the people of the neighbourhood, until he meets with a stranger, who gives him perhaps a few pence for it, or he takes it to a neighbouring town, and sells it for an equally small sum. In either case, he conceals the place where it was found, or probably makes a false statement about it. This is the injury which archæological science sustains from the law relating to treasure trove, and the only effective remedy to be found for it is the spread of antiquarian tastes and antiquarian knowledge, and free trade in antiquities. There is hardly any corner of England at the present day where there are not two or three intelligent antiquaries in the neighbourhood who collect antiquities, or where there is not within a moderate distance a local museum. If the finders of antiquities felt assured that they were at full liberty to sell what they found openly, they would soon be in communication with these local antiquaries or with the curators of museums, and not only would the antiquities be preserved, but also the particulars of their discovery, in which, often, a great part of their value consists. It only requires the power of doing openly that which is now done in concealment.

Accounts of discoveries of CRANNOGES, or lake habitations, have been frequently reported of late in Scotland and Ireland. They are new objects of research, which, as might be expected, is fruitful in discoveries. They appear to belong not to an extremely remote period, for the oldest of them are not probably older than the late Roman period. One was lately traced in lowering the water of Grantstown lake, in Queen's County, Ireland; among the objects found in which were iron nails, with large heads, and other articles in metal, bone, and wood. Traces of crannoges are also stated to have been seen in Lough Neagh. Similar remains have been found in a lake under the glebe-house, in the parish of Aghnamullen, in the county of Monaghan, in connection with which a story is told, which we can hardly help suspecting of a little Irish imagination. The rector, sitting on the island, on the site of the crannoges, one day saw what he thought to be a button on the leaf of a water-plant, which had grown up from the bottom of the lake; but, on examination, it proved to be an old coin, a half-groat of King Edward III., "some of the treasures of the lake being thus lifted to the surface by the natural growth of the plant." No doubt some ingenious individual had picked up the coin and put it on the leaf, probably shortly before it so curiously attracted the rector's attention. To understand his more marvellous explanation of it, we must suppose that the leaf of the water-plant was fully developed in the bottom of the lake, beneath the surface where the coin lay,

and that the stem grew up gradually to the surface of the water, carrying with it the leaves thus developed from the bottom, which is not the usual process of the natural growth of plants.

Within a few months past, antiquaries in Scotland have been occupied in opening several early BARROWS and CAIRNS. In the centre of one of the latter, known by the name of Cairngreg, at Linlathen, in Forfarshire, a cist formed of large slabs of stone was found, from which, when this cairn was opened on a former occasion, a small urn and bronze dagger were taken. Between the two great slabs which covered the cist, one placed over the other, lay, what appeared to be, a fragment of a larger pillar, on which was rudely sculptured the figure of an elephant. This figure is said to be common on stone monuments on the north-east coast of Scotland, which belong to the Christian period; but, it was concluded, from the discovery of the urn and the bronze dagger, that this particular monument belongs to a much earlier date, and that, at the time when the cist was raised, the sculptured upright stone, which had been broken, was used in its construction, and that therefore the sculptures must be assigned to a pre-Christian system. This inference is, however, perhaps rather hasty, for if the sculptured elephant be characteristic in that district of very early Christian monuments, we should be inclined to look upon the sculptured fragment in the cairn to have quite as good a claim to be considered as evidence of the age of the latter as the urn and dagger.

At the last meeting of the Archæological Association, Mr. J. T. Irvine exhibited fragments of ROMAN TILES, taken from the old church at BERKELEY, in Gloucestershire, where they had been used as building materials. They afforded sufficient evidence that there had existed Roman buildings of some kind at this place, and, moreover, that it had been a military post, for these tiles were stamped with the inscription—

DECL. VI,

which was interpreted as standing for *decima cohors legionis sextæ*. If this interpretation be correct—for there appears to be some obscurity about it—it would point to a very remarkable circumstance. The sixth legion was stationed at York, as a check upon Scotland and the north, and is never, as far as we are aware, mentioned in any monuments in the middle or south of England; and why a body of troops should be brought from the legion at York into the remote district of Gloucestershire, where there was one legion close at hand (the second, at Caerleon) and another between Berkeley and York, and much nearer and more accessible (the twentieth, at Chester), is quite inexplicable. Is it possible that these bricks may be memorials of the late period, when, according to the Notitia, the twentieth legion was no longer in the island, and the second had been removed from Caerleon to Richborough in Kent, so that a portion of the only other legion then in Britain, the sixth, might have been employed in repressing disturbances, or resisting invasion in the south-west? T. W.

PROCEEDINGS OF LEARNED SOCIETIES.

BY W. B. TEGETMEIER.

ZOOLOGICAL SOCIETY.

INTRODUCTION OF A LIVING PENGUIN, ETC.—At the recent meetings of this society, the addition of several new and very valuable animals to the collection has been announced by the secretary. Among these may be mentioned the three-banded armadillo, *Tolypeutes prælatus*, described by Burmeister. This species is remarkable, as progressing on the tips of the very long and sharp-pointed claws of the fore feet.

The introduction of a living penguin into the menagerie is to be regarded as a circumstance of still higher importance, as it will enable naturalists to observe the habits and mode of life of this most singular group of fish-like birds. Hitherto all attempts to import these birds have failed, the animals always dying on the passage. The individual now living in the gardens is not the common species, the *Apterodytes demersa* of naturalists, the jackass penguin of the sailors, but the king penguin, *Apterodytes pennantii*. This more ornamented species is at once distinguished by the orange tint of the breast, and of the occipital feathers. In the penguin, every organ is modified so as to suit its aquatic habits; the sickle-shaped wings are perfectly useless in the air, hanging pendant by the sides of the upright body of the animal; in the water they become powerful paddles or fins, urging the progress of the bird with a sufficient degree of rapidity to enable it to hunt down and capture the fish on which it feeds. The legs and tarsi are extremely short, and are situated so far backward that the body of the bird is supported in a perfectly perpendicular attitude, the animal, when at rest, supporting itself on the two feet and the tail, as on a flattened tripod. The common penguin is described by Mr. Darwin and other naturalists as progressing on land on its breast, using its paddles or modified wings as fore legs. The specimen in the gardens does not seem to move in this manner, but walks or rather waddles on its webbed feet with very short and toddling steps. The specimen, which is placed in the pelican enclosure, to the left of the chief entrance to the gardens, is very tame, following the keeper for its food; the general appearance is that of considerable intelligence.

As very many years may elapse before another specimen of these birds is introduced into this country, the opportunity of examining this specimen should not be allowed to pass away unimproved by all who claim the title of Intellectual Observers.

MANCHESTER PHILOSOPHICAL SOCIETY.—*March* 7.

THE ACTION OF SEA WATER ON METALS.—Dr. Crace Calvert read an account of a very valuable series of experiments undertaken

to investigate the action of sea water on metals and alloys. It was found that when placed in a limited portion of water, iron, the metal now used so largely for ship-building, was attacked with the greatest rapidity, but that the action of the sea water upon it is materially lessened when it is coated with zinc, and that, therefore, it would repay ship-builders to have the iron galvanized—particularly as iron and oak timber, in contact, are prevented from exerting their mutually destructive action if the metal has been previously coated with zinc. As lead appears almost entirely unacted on by sea water at rest, it appears possible that it might be rendered available, although pure lead is far too soft to withstand the wear and tear to which ships' bottoms are subjected. In investigating the action of sea water on brasses of various compositions, Dr. Calvert spoke very favourably of the Muntz metal, which seems to owe its durability to the small proportion of lead and iron that it contains. In the discussion which ensued, Mr. Robinson stated that he had found an alloy of lead, tin, and antimony resisted the action of sea water better than any other alloy, or any pure metal that he had experimented with.

ENTOMOLOGICAL SOCIETY.—*April* 2.

Occurrence of Insects in Snow.—Mr. Pascoe, the president, stated, that when passing over the snowfield of Monte Moro, at an elevation of 8000 feet, during last July, he discovered several sharply defined cylindrical holes about an inch in depth, at the bottom of which was either a small mass of matter resembling peat in appearance, or, what was still more frequent, a dipterous or ichneumonideous insect. Mr. Pascoe explained their occurrence by supposing that the insects had alighted on the snow, and having become torpid, owing to the cold, had gradually sank into the snow, from the radiation of heat from their own bodies.

Recalling to mind the simple experiments of Franklin, to prove the varying amount of absorption of solar heat by patches of different coloured cloths placed on snow, as measured by the depth to which the cloth melted the snow below it, it appears much more probable that the sinking of the insect into the snow was due to its becoming warm by the absorption of heat, and the consequent melting of the snow. On the other hand, the loss of heat by radiation would cause the snow to become more solid and firm.

ROYAL SOCIETY OF EDINBURGH.—*April* 3.

Economic Value of Food of Soldiers.—Dr. Lyon Playfair read a paper on the food of soldiers in war and peace. In this country, three quarters of a pound of meat and one pound of bread are issued daily to the troops, the rest of their food being furnished from their own pay. On investigating the total diet of nearly five hundred men, in garrison at Chatham, for twelve days, Dr. Playfair found that, stated in ounces and tenths, the returns were as follows:—

Flesh formers	5·1
Fat	2·9
Starch, etc.	22·2

This dietary closely resembles the war dietary of the continental armies, except that as potatoes are largely used in garrison, and not on active service, the starch and consequently the total carbon is increased. Dr. Playfair concludes that a war diet for soldiers should have at the very least a daily supply of five and a half ounces of flesh formers in the food, as this quantity is absolutely necessary to enable men to march fourteen miles daily, with a weight of sixty pounds of arms and accoutrements, without exhausting their own tissues to obtain the necessary amount of muscular force.

GEOLOGICAL SOCIETY.—*April* 5.

On the Chalk Districts of England.—Mr. Whitaker made several interesting valuable communications on the arrangements of the beds in the chalk districts. In the Isle of Thanet, a bed of comparatively flintless chalk overlies one with many flints. The higher division, or *Margate chalk*, contains but few scattered flint-nodules, and shows well-marked N.W. and S.E. joints. The lower division, or *Broadstairs chalk*, on the other hand, is less jointed, and has many continuous layers of flint. The beds form a very flat arch, as may be seen along the coast from Kingsgate to Pegwell, between which places the flinty chalk rises up from below that with few flints. It is remarkable that in this neighbourhood the Thanet beds are conformable to the chalk, the green coated nodular flints at the bottom of the former resting on a peculiar bed of tabular flint at the top of the latter. In carrying on the geological survey of Buckinghamshire, the Totternhoe stone (with its underlying chalky marl), which had been sometimes thought to be the representative of the Upper Greensand, was traced south-westwards into a part where that formation was fairly developed, and was then found to overlie it. The divisions of the chalk in Buckinghamshire are, in ascending order—

(1.) Chalk-marl, with stony layers here and there, and at top.
(2.) The Totternhoe stone, generally two layers of rather brownish sandy chalk, hard, with dark grains of small brown nodules.
(3.) Marly white chalk, without flints.
(4.) Hard-bedded white chalk without flints, forming generally a low ridge at the foot of the great escarpment.
(5.) The thick mass of white chalk without flints, or with a very few flints in the uppermost part, and at top.
(6.) The "chalk-rock," a thin hard bed or beds, with green-coated nodules.
(7.) The chalk with flint, the lowermost part only coming on near the top of the escarpment, the rest bed by bed over the tableland southwards, the angle of dip being rather more than that of the slope of the ground.

In the Isle of Wight, as in Oxfordshire, etc., the division between the chalk with flints and chalk without flints, is marked by a peculiar bed ("chalk-rock"), hard, of a cream-colour, and with irregular-shaped green-coated nodules, which may be seen in many of the pits on the southern flank of the chalk-ridge, where, however, it is very thin. Mr. Whitaker disagreed with the inference that the chalk was eroded before the deposition of the Tertiary beds, which has been drawn from the irregular junction of the two in the cliff-sections, and thought that the irregularity had been caused rather by the formation of "pipes" after the deposition of the latter, although he did not deny that there was other evidence of denudation of the chalk before the deposition of the Tertiaries upon it.

MICROSCOPICAL SOCIETY.

The annual *soirée* of this society was held on Wednesday, the 19th of April, and was very numerously attended. Messrs. Powell and Lealand exhibited one of their $\frac{1}{20}$ths, which attracted a great deal of attention, though the merits of such a remarkable objective cannot be adequately appreciated in a crowded assembly, in which the instrument is never free from vibrations. Mr. Ross and Messrs. Smith and Beck exhibited some fine objects, as did Messrs. Baker, How, Steward, Robbins, and a variety of other makers. Dr. Carpenter showed some remarkable specimens of *Eozoon Canadense*. Mr. Browning exhibited some spectroscopes, including the new direct vision pattern devised by Mr. Herschel. In the course of the evening Mr. How showed with a gas microscope a series of photographs of diatoms, etc., by Dr. Maddox. Many of them possessed great merit, but we think a better definition would have been obtained by lower magnification. He also exhibited in a similar way photographs of various animals.

The members of the society did not exhibit much, and we think on future occasions more pains should be taken to display a series of objects representing the principal novel microscopic facts of the year.

ROYAL ASTRONOMICAL SOCIETY.—*April 12th.*

Colonel Strange read a paper, "On an Aluminium Bronze Axis, and on certain new methods of Adjusting Transits." The author remarked that in November, 1862, he had before this society advocated the use of the new metallic alloy referred to, in the construction of astronomical instruments, and now some having been made, he could practically confirm the good opinion previously formed. One exception had been found to complete success, viz., that it did not answer for the graduated part of circles, as it tarnished rather rapidly; but other difficulties had yielded to scientific treatment, and the transit axis now exhibited and made by Messrs. Cooke was, notwithstanding its lightness and thinness of metal, probably the stiffest axis in existence. The axis was intended

for a 5-foot telescope, it was 33½ inches between the bearings, the central tube was 9 inches in diameter and 0·15 inch thick, but strengthened by internal webs, and weighed only 56 pounds. The modifications in the adjustments related to three points: 1. The adjustments for azimuth and horizontality. 2. The application of the level. 3. The mode of collimation. 1. As to the raising and lowering the axis, and moving it in azimuth. These operations are generally effected by sliding parts, which are objectionable as they must be clamped, and this especially in the vertical slide produces great strain. It is proposed that a massive three-rayed piece of cast iron shall rest on each pier not fixed to it, but standing on three feet, with a central bolt to prevent accidental displacement. This will admit of expansion in all directions. The bearings in which the axis revolves rest on other three-armed pieces made of gun metal, and standing on the iron ones. The gun metal piece on one pier is acted on by screws having antagonistic motions, which shift the bearings in azimuth as required. The other gun metal three-armed piece has foot screws like a theodolite, for levelling the axis. It has a circular level which is first adjusted, and the screws are then moved as necessary, one of them having a lever apparatus, by which great delicacy of motion is obtained. No strain can exist under these arrangements, gravity being the only force called into action. An improvement has also been made in the bearings, the under surfaces of which constitute parts of spheres; and these work in cups, so that no amount of tilting will interfere with the points resting securely in their bearings. 2. As to the mode of applying the level to the axis. This is usually effected by a level striding from one point to the other, but such levelling cannot be performed with the telescope directed to the zenith where error of level is most injurious; and Mr. Cooke therefore proposes to have several levels attached to the telescope instead. There will be two near the central tube, and one at each end, all parallel to the axis. It is usually assumed that if the points are horizontal the telescope will describe a vertical curve; but this is not a certain inference; and it will be better to watch the centre, where any unsymmetrical flexure of the axis will be apparent, or any lateral deviation of the tube be made evident by the end levels. 3. As to testing the collimation error. It is intended in this instrument, which is a portable one made for the great Indian survey, to employ Benzenberg's method of observing the reflection of a wire cross in the eye-piece from a trough of mercury; and in order to avoid the vibrations of that fluid a plate of glass is to float on the metal, the under surface of which will form a brilliant mirror. Such plate ought to have two plane surfaces, parallel to each other, and the glass should be of uniform density. The first condition of a plane surface can be ensured by careful grinding; and should the other two not be obtained the reversal of the trough in azimuth, and observations in that position, would neutralise the error.

In an interesting discussion which followed the reading of the paper, Colonel Strange said the antagonistic screws of the azimuth

bearing were only used as a motive power and then released; that the levels being always attached would not run the risk of any jar in handling and placing on the pivots; and that he thought if the telescope described a true vertical curve the form of the joints was not so important as generally supposed, although he could still test them if necessary. The principal use of the instrument would be for obtaining the longitudes of the different stations of the survey (of which an arc of 10 degrees was now waiting for their determination) by electric telegraph signals, and the transit would remain one or two months at each station.

PROGRESS OF INVENTION.

NEW METHOD OF CEMENTATION.—In certain experiments made by M. L. Cailletet he found that cast iron, by long exposure to a temperature less than that which causes fusion, loses an amount of carbon which renders it very similar in constitution to steel. It differs, however, considerably from the latter, since it is forged with difficulty, and the bars obtained from it are incapable of being tempered. It is very brittle, and when broken resembles some kinds of oxide of manganese. Pursuing these researches further, he discovered that when bars of iron are heated for about twenty hours to a temperature somewhat under that at which gold melts, in contact with granulated grey cast iron, which has been carefully freed from all fatty matters and any adhering carbonaceous substances, in boxes from which the air is excluded, they are converted into steel of very good quality. They must be *in contact* with the cast iron, since, as was proved by experiment, their conversion is not due to the gases of the furnace having entered the boxes, those not in contact with the cast iron not being converted. This discovery is capable of being applied to a very practical purpose, since, if engraved and polished plates of wrought iron are used instead of the bars, they are cemented without suffering the least distortion, or even having their surface tarnished. Neither are blisters or other imperfections, so usual when steel is cemented with carbon, produced upon them.

MODE OF RENDERING WOOD PLASTIC.—A new and very simple method of effecting this has been lately discovered. It consists in forcing dilute hydrochloric acid through the cells of the wood, at a pressure of about two atmospheres. This impregnation must be continued for a length of time, dependent on the nature of the wood. The bark is not previously removed, and by a very simple arrangement the fluid is introduced at one end of the log, and passes out at the other. If while the wood is still wet it is exposed to pressure, the cells having been first washed out with water, its volume may be reduced to a tenth of what it was originally; the fibres being brought into the closest contact, without being fractured or torn; and when dry they have no tendency to separate again. If it is pressed in dies, their details

are brought out with the greatest sharpness, and the most perfect accuracy. Impregnation in this way can be used for a variety of purposes. After the action of the hydrochloric acid, washing out with water, and drying, the wood may be cut with remarkable facility, and it answers admirably for the purposes of the carver. The drying is effected by forcing air, at a temperature of about 100° Fahr., through the cells. The moisture is thus carried off with great rapidity; and, as the contraction is uniform through the whole mass, no cracks are produced. Dyes also may be introduced in the same manner into the entire substance of the wood, or matters calculated to preserve it from decay. Soluble glass, or recently precipitated silex, renders it both very durable and thoroughly incombustible.

New Self-registering Thermometer. — This new maximum thermometer, which is of great simplicity, resembles the ordinary spirit thermometer, except that a small enlargement is blown on the stem, at about one-third of its length from the bulb. In this enlargement is placed a small globule of mercury, which, as long as the spirit continues to ascend in the stem, remains in its place, but when the spirit falls, descends along with it, dividing it into two portions, the upper one of which will continue nearly equal to the greatest distance to which the spirit reached above the enlargement. As that distance is easily measured on a scale, placed for the purpose, the maximum height which the temperature attained during a given interval, is easily found, no matter how low the temperature may have subsequently become. Heating the instrument until the globule of mercury reaches the enlargement, and then laying it on its side until it cools, prepares it for a new observation.

Utilization of South American Beef.—Sixteen years ago Liebig obtained the pure essence of meat, and demonstrated that it contains all the nutritive matter of the animal substance; but as, on the score of economy, there was no inducement to prepare it, its use has been nearly confined to invalids, to whom it is of the greatest benefit. It is exceedingly nutritious and very digestible, it hastens the recovery of strength in an astonishing way, and may be given in gastric fever and other diseases in which ordinary food cannot be digested. It is so agreeable that after their recovery patients continue to use it with pleasure, which is not the case with preparations of gelatine. The latter contain very little nutriment, and they soon become disagreeable to the palate. Eighty per cent. of the extract of meat is nutritive matter, but only four or five per cent. of the gelatine. According to the calculations of Liebig, one pound of the former, with bread, potatoes, and salt, would afford a meal to 128 persons. It may be kept for a very long time: Liebig found some he had prepared fifteen years before, perfectly fresh. In fact, it seems to possess antiseptic properties. A quantity of it, in pots, merely covered with paper, was stored in a damp cellar. Even the inside of the pots became mouldy, but there was no mould whatever on any part of them which was in contact with the extract. The latter is extremely portable, since one pound of it contains the nutritious matter of thirty-two pounds

of meat. If it is made poorer than this, or if it is attempted to adulterate it, it will not keep. All these excellent properties have not been able to bring it into general use, on account of its unavoidable dearness when made in Europe. But it seems likely that the preparation of it will very soon become the means of saving a vast amount of valuable meat, hitherto allowed to go almost entirely to waste, and thus add greatly to our supply of nutritious and agreeable food. Giebert, a German engineer, like thousands of others, was struck with the vast herds of cattle slaughtered in La Plata merely for their hides and tallow, the meat being abandoned from the impossibility of preserving it by the ordinary methods. But being, as it happened, aware of Liebig's experiments, the thought luckily occurred to him of extracting the nutriment from this meat on the large scale; and the undertaking is already so far advanced, that we may hope soon to derive advantage from it. The process required for obtaining the extract is very simple. The fresh beef is carefully separated from all fat, bone, and tendon—fat or gelatine would cause it soon to become rancid and mouldy; it is then chopped up, and placed with a small quantity of water in a water bath. According as any fatty matter or albuminous coagulation makes its appearance, it is removed. After some time the extract thus produced is poured off from the fibre, which now contains so little nutriment that it is quite incapable of supporting animal life, and is placed in earthen or other vessels. The latter do not require to be hermetically sealed in any way, and may indeed be closed in the manner usually adopted with preserves.

NOTES AND MEMORANDA.

THERMO-ELECTRICS.—M. Bünsen finds that pyrolusite exceeds bismuth in thermo-electric power, and copper pyrites possess the same quality in a still higher degree.—*Pogg. Ann.*

THE LEG OF THE OSTRICH.—The Rev. Samuel Haughton, M.D., F.R.S., has a paper in the *Annals of Natural History* on the leg of the ostrich, founded upon the examination of a bird recently defunct in the Dublin Zoological Gardens. After giving a variety of important anatomical details, he observes, "in the act of running, the leg of the ostrich is to be regarded as a jointed lever, having four joints, the hip, the knee, the heel, and the metatarsal joints. As the animal springs from foot to foot, the whole limb on reaching the ground is bent as far as possible at each of these articulations; and, as the spring is made, the muscles proper to each joint increase the angle made by the bones uniting at the joint, so that the effect of the whole is to unbend the limb, and give it a maximum of extension at the moment of leaving the ground. During the spring the antagonist muscles again bend the joints, so that on next touching the ground it is at its maximum of flexion, again waiting to be unbent by the muscles that open the angles of the joint, and so on; as long as the animal runs, it is thrown alternately from each foot in contact with the ground as from a catapult, and advances by successive leaps or springs from foot to foot." Dr. Haughton also gives the calculations by which he arrives at the conclusion that "the force expended in propelling the body of the ostrich forward is ten times the force employed in restoring the legs of the animal preparatory to its next spring."

SUPPOSED COMPOSITION OF NITROGEN.—We have received a pamphlet by Mr. Henry Kilgour, in which he endeavours to establish the proposition that nitrogen is an allotropic form of carbonic oxide. He arrives at this conclusion

from some similarity of properties, from identity of atomic weights and combining volumes, and from their being approximately of the same specific gravity. Such facts as Mr. Kilgour adduces are well worth consideration; but they do no more than raise a presumption, to be confuted or confirmed by other considerations.

Resuscitation of Snails.—*Cosmos* states that M. le Baron Aucapitaine has recently informed the *Société de Climatologie Algerienne*, that in 1858 he gathered specimens of *Helix lactea* apparently dead, and lying on the route between Touggourt and El Oued, exposed to a temperature of 50° to 55° C., or 122° to 131° F. It was said that no rain had fallen in this district for five years. In 1862 the baron discovered some of the snails at the bottom of a box, in a paper bag which had contained tobacco, and which was buried amongst books. He threw the snails into water, intending to clean them and present them to Commandant Lache, and was much surprised at finding them alive the next morning.

Aqueous Solution of Aniline Colours.—M. Gauthier de Claurry has a paper in *Comptes Rendus* on the substitution of other substances for alcohol in the solution of dyes obtained from aniline and its congeners. He finds that gums, mucilages, soaps, especially almond, starches, including those from seaweed and lichens, particularly *fucus crispus*, glycerine, gelatine, etc., impart to water the property of dissolving these colours. The most advantageous substances are decoctions of the root of an Egyptian soapwort (*Gypsophila strutium*), or of a bark known in commerce as *Panama* (*Quillaia saponaria*).

Phosphorescence of the Sea.—The Minister of Marine has transmitted to the French Academy a report from the commander of the "Augustin," which left Marseilles on the 7th March, 1864, for Pondicherry, and returned to the former place on Feb. 14, 1865. He says that on 1st Jan., 1865, being from 13° 30′ N. lat. and 30° 50′* W. long., to 17° 20′ N. lat., 33° 20′ W. long., a distance of about 275 miles, the sea was so phosphorescent that at night he could not distinguish the horizon. The light was bright blue, but in daytime the sea looked yellowish. The water contained a great number of little white threads, 4 or 5 millimetres long (about 15 to 19 hundredths of an inch), which assumed an ovoid form, after remaining for some hours in a glass, 3 millimetres long, and half a millimetre thick, "in the midst of which a ring was formed, which diminished their thickness by half." Gradually these objects soldered themselves together in groups of 12 to 15, "making a kind of worm" of a bright grey tint. Some hours later a yellow spot and some bright orange spots were seen at the ring, and the creatures then looked like some he had seen at various places, and particularly at St. Helena, and which were known as *frai de poisson*, or *frai de baleine*.

Nature of Yeast.—M. Hoffmann, of Giessen, has sent a paper to the French Academy on this subject. He says that wort, after a sufficiently prolonged ebullition, neither ferments or gives rise to any organisms by mere contact with air, provided no atmospheric dust is admitted. Beer yeast gives rise to the *Penicillium glaucum*, or blue mould, while baker's yeast, from brandy distilleries, either produces that plant alone, or the *Mucor racemosus* in conjunction with it. By sowing the spores of these plants in sugar solution, he obtains a fresh crop of yeast.

The Penguin at the Zoological Gardens.—This bird is a most interesting addition to the collection of the Zoological Society. Its colours are much handsomer than are shown in stuffed specimens, and its attitude and upright mode of walking, or rather waddling, are remarkably grotesque. Although in its natural condition it passes a great portion of its life in the water, it manifests no disposition to swim in the little pond provided for it, but much enjoys a shower-bath, frequently administered with a garden syringe, terminating in a fine rose. It is very tame and good-natured. The wings are reduced to mere flappers, covered with extremely short, close-set feathers, and the pupil of the eye is often seen contracted to a minute spot. It feeds freely upon fish, taking several meals a-day, judiciously regulated as to quantity.

Experimental Proof of the Identity of Heat and Light.—Whatever conviction may have been entertained hitherto as to heat and light being merely

* According to French reckoning, our first meridian at Greenwich is + 0h. 9m. 21s.

modifications of the same thing, it could scarcely be considered as demonstrable by experiment. Professor Tyndall has, however, now succeeded in doing this. He was led to the important results he has attained by the discovery, a few years since, of a medium perfectly pervious to radiant heat, but at the same time perfectly opaque to light. To effect the change of heat into light he obtains a cone of convergent rays by concentrating the rays of the electric light with a small mirror, and then intercepts all those which are luminous by an opaque solution of iodine in bisulphide of carbon, which allows all the calorific rays to pass on to a focus. The latter, even in a darkened room, is completely invisible; but any combustible substance placed within it is immediately inflamed, as described in our number for March, p. 161. If this combustible is zinc, or magnesium, for example, the light produced is intensely brilliant. To render it impossible that its luminous character should be due to the process of combustion, platinum was thus heated *in vacuo*, and the light emitted produced a perfect spectrum. The invisible picture of the charcoal points, so to speak, was changed into a visible by decreasing the refrangibility of the rays—that is, by transformation of the heat into light; and every change made in the position of these points was distinctly perceptible on the platinum. This may be looked upon as the completion of what was begun thirteen years ago by Professor Stokes. The latter rendered the ultra-violet rays visible by diminishing their refrangibility; Professor Tyndall has rendered the invisible rays belonging to the opposite extremity of the spectrum visible by increasing theirs. A similar proof of the identity of light and heat was, indeed, suggested by Aikin at the meeting of the British Association in 1863; but he proposed to use sun light, and has not as yet been successful, though he employs a mirror three feet in diameter. Professor Tyndall, by using the electric light, attained his object, and with the use of a mirror only four inches in diameter.

The Microscope and Spectroscope Combined.—Mr. Sorby places a small prism beneath an achromatic condenser, and allows light to fall upon it through a slit placed at a certain distance in front of a lamp. Exceedingly dilute solutions of blood and certain other substances being interposed, produce the dark bands discovered by Professor Stokes, and when the spectrum is viewed through the microscope, with a low power, they are readily seen. Mr. Browning has carried out Mr. Sorby's idea in a very neat and convenient way; but we doubt whether the intervention of a microscope will prove to be the most advantageous mode of viewing very delicate absorption bands. We made some experiments at Mr. Browning's, which suggest the correctness of this view. First we reduced by further dilution a *very* weak solution of blood in water, until the absorptive action on the prismatic spectrum was very faintly seen under the microscope. The solution was then examined by a large and fine single prism spectroscope, having considerable dispersion, and no absorption band could be seen. Mr. Browning at once suggested the true cause, viz., too much dispersion. A smaller spectroscope, with less dispersive power, was then tried, and the absorptive action at once became visible. It is evident that while the separation of closely adjacent lines in spectra can only be affected by considerable dispersion, a large amount of that kind of action thins out, and renders invisible, very delicate absorption bands. A spectroscope to show such bands should have such an angle as to produce little dispersion, and the spectrum should be viewed with slight magnification, or with none at all.

Light Streaks in the Crisian Sea.—Mr. Slack states that on the 2nd of April, in the evening, when the moon was about 6 days 14 hours old, the Crisian Sea presented an unusual appearance, being striped with delicate bands of light radiating from the vicinity of a small mountain near Picard. Several light spots were also noticed in parts of the same sea, which are usually dark. Mr. Slack inquires whether other observers noticed these appearances.

Painted Houses, Upper Egypt.